TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Bulkley Timber Supply Area Analysis Report

April 2001

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Bulkley Timber Supply Area Analysis Report

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Preface

This report contains a timber supply analysis and socio-economic analysis and is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia.

To determine allowable timber harvesting levels, the chief forester must have an up-to-date assessment of the timber supply based on the best available information and reflecting current management direction. **The report that follows provides this assessment but should not be construed as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the *Forest Practices Code (FPC) of B.C. Act* and official land-use decisions made by Cabinet.

Focussing the assessment on the implications of current practices rather than looking at a number of different management schemes expedites the analysis process, allowing analysis of all TSAs in the province every five years. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC) the chief forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the chief forester with some of the information necessary for these considerations.

This report is the third of five documents that will be released for each TSA as part of the Timber Supply Review. (The first two documents are the information report and the data package). A fourth document called the public discussion paper will summarize the technical information and will provide a focus for public discussions of possible timber harvest levels. The fifth will outline the chief forester's harvest level decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Bulkley Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over the short- (next 20 years), medium- (21 years to 100 years from the present) and long- (beyond 100 years from the present) terms. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. **It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Bulkley Timber Supply Area (TSA) covers approximately 762 500 hectares in the northwest interior of British Columbia. It is bounded by the Telkwa valley in the south, and extends north to the headwaters of the Nilkitkwa River. About 65% of the Bulkley TSA (approximately 496 000 hectares) is considered productive forest area managed by the Crown. Currently about 68% of the productive forest, or 45% of the total TSA, is considered available for timber harvesting under current forest management practices. These practices follow the standards and legislation set out by the *Forest Practices Code* and the agreements made under the Bulkley Land and Resource Management Plan (LRMP). Within the area available for timber harvesting, most of the forests are dominated by balsam species, although there are also significant areas dominated by lodgepole pine, spruce, and hemlock species.

The results of this timber supply analysis suggest that harvest levels can be maintained at the current AAC for the Bulkley TSA (882 000 cubic metres per year after accounting for the woodlot licences issued since the last determination) for the next 10 years without creating future timber disruptions, if followed by a series of controlled reductions over the subsequent 40-year period, to a long-term harvest level of 554 945 cubic metres per year. The existing partition of 367 000 cubic metres per year for marginal sawlog and pulpwood can be maintained for 20 years. The contribution from these stand types decreases to 26 700 cubic metres per year by decade 5 and dwindles to zero by decade 10.

These results reflect current knowledge and information on forest inventory, growth, and management. However, uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses showed that these uncertainties can affect timber supply to varying degrees.

The largest potential effects on projected harvests over the short term are associated with uncertainties in estimates of timber volumes in existing stands. An audit conducted in 2000 suggested that the inventory estimate of volumes in the operable portion only of the TSA (approximately the timber harvesting land) may be 12% higher than estimates based on ground measurements. If existing stand volumes are indeed 12% lower than the inventory estimates and the current harvest level is maintained, this analysis shows that timber supply will decline to 11.2% below the base case level during decades six to eleven. After decade eleven, when the harvest is mainly from managed stands, timber supply returns to the same level as projected in the base case.

Medium-term timber supply is affected by many of the factors tested through sensitivity analysis. Because the long-term harvest level is about 37% lower than the starting harvest level, uncertainties that affect either the total amount of existing volume, or the ability to access existing volume during the first 100 years will affect medium-term timber supply. The medium term is most affected by changes in: the size of the timber harvesting land base; volumes from existing stands; volumes from managed stands; the rules governing which stands are selected for harvesting; old-growth site index estimates; forest cover requirements for management of visual quality; and the standards used to define merchantable trees.

When the timber harvesting land base was increased by 9.2%, through the addition of areas suitable for cable logging, medium- and long-term timber supply increased by 5.7%. When the timber harvesting land base was decreased by 11.5%, through the removal of low site areas, medium- and long-term timber supply decreased by 4.3%.

Executive Summary

Managed stand volumes were projected to increase if genetically improved spruce and pine seedlings were used in future plantations. If provincial utilization standards were used to determine tree merchantability, managed stand volumes were lower than projected in the base case. If managed stand volumes were 10% higher than estimated then medium- and long-term timber supply were 10% higher. If managed stand volumes were 10% lower than estimated then medium- and long-term timber supply were 10% lower than the base case.

Another factor with potential impacts on medium- and long-term timber availability is the rule used to set harvest priority. The analysis showed significant impacts when merchantable stands (older than the minimum harvestable age) were chosen at random for harvesting, rather than the relative oldest first rule used in the base case. It is unlikely that the relative oldest stands in the TSA are always given the highest harvest priority. The analysis showed the potential impacts on timber supply resulting from changes to harvest priority.

If site productivity of existing old-growth stands is underestimated, as suggested by recent research, yields from stands regenerated after harvesting old growth could be significantly higher than projected in the base case. In the Bulkley TSA, stands older than 140 years comprise 64% of the timber harvesting land base and the old-growth site index adjustment resulted in a 31.5% increase in medium- and long-term timber supply. Results from the operational adjustment to site index study (OASIS), which relies on the biogeoclimatic ecosystem classification (BEC) of the land base to assign site productivity, indicated that medium- and long-term timber supply could be 36.9% higher than the base case projections.

In the base case, management objectives for visual quality applied only to 1.2% of the timber harvesting land base. However, there are draft visual quality objectives for a further 17.3% of the timber harvesting land base. If these draft areas were declared as visual quality objectives (VQOs) in the Bulkley TSA, medium- and long-term timber supply would be reduced by approximately 4.3%. If the disturbance in these visual quality areas were in the middle of the allowable range rather than at the upper end of the range as assumed in the base case, medium- and long-term timber supply were expected to be 9.7% below the base case.

Long-term (over 100 years from now) timber supply is affected by uncertainties in all the above factors with the exception of changes to existing stand volumes.

In conclusion, this analysis indicates that based on current inventory, growth and yield, and forest management information, timber harvests in the Bulkley TSA can be maintained at the current level for 10 years. The existing partition of 367 000 cubic metres per year for marginal sawlog and pulpwood can be maintained for 20 years. The analysis indicates that several factors related to the current forest inventory and management regime could affect timber supply. However, except for the likelihood that existing stand volumes may be overestimated, and site indices for old-growth stands may be underestimated, there is no conclusive evidence to suggest that significant inaccuracies exist in the information used in this analysis.

The socio-economic analysis for the Bulkley TSA indicates that the base case forecast of 882 000 cubic metres could support a provincial total of approximately 828 person-years of direct forestry employment. Residents of the Bulkley TSA account for approximately 75% of this direct employment. Direct forestry activity in the TSA supports a further 967 person-years of indirect and induced employment across the province. The base case forecast, if fully harvested could provide the provincial government with average revenues of about $28.4 million per year.

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Introduction

Timber supply* is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions about whether a stand is available for harvest often depend on how its harvest could affect other forest values, such as wildlife or a recreation area.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood. Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area). For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the chief forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.

Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 *of the* Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data. The B.C. Forest Service forest inventory* plays a major role in this. The second step is using this data along with a timber supply computer model or models* to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

The following sections outline the timber supply analysis for the Bulkley TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Timber supply analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. This is followed by a summary and conclusions for the timber supply analysis in Section 6. Section 7 shows results of a socio-economic analysis for the Bulkley TSA. Appendixes A and B contain further details about the data and assumptions used in the analysis.

As part of the timber supply review (TSR), information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis provides information for the chief forester and the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Bulkley TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry; and by assessing employment and income implications of the timber harvesting levels projected in the base case.

The analysis includes estimates of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and other woodlands-related, processing, and silviculture. Employment is measured in person-years*. Employment income is calculated using average industry income estimates.

Data on direct employment, harvest levels, and fibre flows was obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Forest inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Introduction

Indirect and induced employment figures were calculated using the Bulkley TSA and provincial employment multipliers* developed by the Ministry of Finance and Corporate Relations. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for the indirect and induced impacts.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions* and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as general indicators.

Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

1 Description of the Bulkley Timber Supply Area

The Bulkley Timber Supply Area (TSA) is situated in northwestern British Columbia in the interior portion of the Prince Rupert Forest Region. Covering approximately 762 500 hectares, the Bulkley TSA is part of the Bulkley/Cassiar Forest District and is administered from the forest district office in Smithers. The forest district also includes the Cassiar TSA and a very small, mainly inaccessible portion of Tree Farm Licence* 1.

The Bulkley TSA is located on the eastern drainage* of the Skeena River. It is bounded by the Hazelton Mountains to the west, the Telkwa River watershed* to the south and the Babine Mountains to the east, and extends north to the headwaters of the Nilkitkwa River. The Bulkley River runs through the centre of the southern portion of the TSA. The terrain in the Bulkley TSA varies from wide river valley bottoms to high mountains.

Due to its location between interior and coastal climates, the Bulkley TSA includes diverse ecological features. The dominant tree species in the TSA are subalpine fir (balsam), spruce and lodgepole pine. Mountainous terrain and high elevations limit the amount of land considered suitable for timber production in this TSA. For the current timber supply analysis, about two-thirds of the TSA (about 496 000 hectares) is considered productive forest land managed by the B.C. Forest Service. Approximately 68% of that productive forest land (about 340 000 hectares, or 45% of the total TSA land base) is considered available for harvesting under current management practices.

In 1995 the chief forester set the current allowable annual cut (AAC) for the Bulkley TSA at 895 000 cubic metres. This represented no change in total AAC from the previous determination, but a partition* of 367 000 cubic metres for the harvest of marginally economic forest types* was included.

Significant changes in forest management legislation, policy and practices have occurred since the last timber supply review was completed. These include: implementation of the *Forest Practices Code (FPC)**; management direction from the Bulkley Land and Resource Management Plan (LRMP)*; formal establishment of landscape units* and biodiversity emphasis options (BEOs), and the reclassification of the TSA using a harvest method mapping (HMM) system. As a result of these and other changes, the analysis presented in this timber supply review (TSR) are not directly comparable to the previous one.

Tree farm licence (TFL)
Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.

Drainage
The surface and sub-surface water derived within a clearly defined catchment area, usually bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed. The term is sometimes used to describe an operating area or location.

Watershed
An area drained by a stream or river. A large watershed may contain several smaller watersheds.

Partition
A portion of the AAC that is attributable to certain types of timber and/or terrain.

Forest type
The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Land and Resource Management Plan (LRMP)
A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.

Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

1 Description of the Bulkley Timber Supply Area

The main communities in the Bulkley TSA are located along the Bulkley River in the southern portion of the TSA. The largest community is Smithers, home to about 42% of the TSA population of 13,000. Other smaller communities include Telkwa, Moricetown and Fort Babine.

Both residents and visitors enjoy the varied recreational opportunities available in this TSA. The mountainous terrain, lakes and rivers of the area provide a wide range of front- and backcountry recreational opportunities including hunting, fishing, climbing and mountaineering, camping, wildlife viewing, kayaking, canoeing, rafting, horseback riding, snowmobiling, and cross-country and downhill skiing. Several areas within the TSA offer high-quality wilderness recreation opportunities and attract visitors from the U.S. and overseas. As a result of implementation of the Bulkley LRMP, the TSA now includes seven new provincial parks: Babine River Corridor, Nilkitkwa Lake, Rainbow Alley, Netalzul Meadows, Boulder Creek, Babine Mountains and Call Lake. Burnt Cabin Bog which was awaiting approval as the eighth provincial park was instead approved as an Ecological Reserve through a June 29, 2000 Order-in-Council.

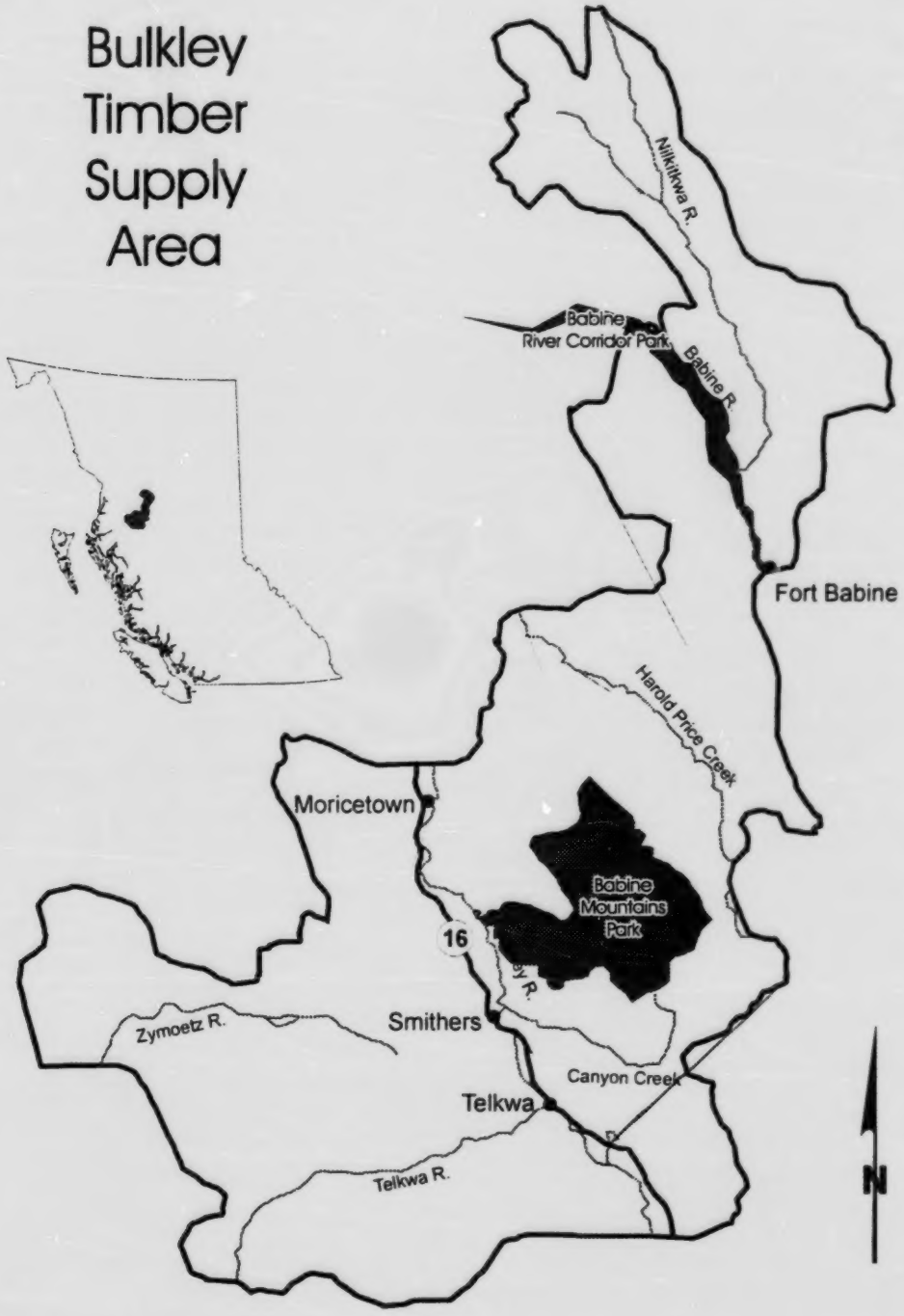

Figure 1. Map of the Bulkley Timber Supply Area, Prince Rupert Forest Region.

1 Description of the Bulkley Timber Supply Area

1.1 The environment

Due to its location and topography, the Bulkley TSA is ecologically diverse. This is reflected in the presence of six biogeoclimatic zones*.

The most common zone is the Sub-Boreal Spruce (SBS) zone, which occupies about 40% of the area of the TSA, from valley bottoms to about 1200 metres elevation. This zone is characterized by severe, snowy winters and relatively warm, moist and short summers. Annual precipitation is moderate. The major tree species are hybrid white spruce, subalpine fir (balsam), lodgepole pine, trembling aspen, western hemlock, black cottonwood and paper birch.

At elevations above the SBS occurs the second most common zone, the Engelmann Spruce–Subalpine Fir (ESSF) zone which covers about 38% of the TSA. This zone has a relatively cold, moist and snowy continental climate. Growing seasons are cool and short while winters are long and cold. The major tree species are Engelmann spruce, hybrid white spruce and balsam. Western and mountain hemlock, amabilis fir, whitebark pine, trembling aspen and lodgepole pine also occur.

Above the ESSF is the Alpine Tundra (AT) zone with its cold, windy and snowy climate. This zone occupies about 11% of the TSA and is characterized by low growing season temperatures and a very short frost-free period. By definition, the AT is treeless but at lower elevations of this zone trees are common in stunted form. The most common species are subalpine fir, Engelmann and white spruce, mountain hemlock and whitebark pine. Otherwise, shrubs, herbs, mosses and lichens dominate this zone.

The Interior-Cedar Hemlock (ICH) zone occurs sporadically at lower elevations below the ESSF. Its climate is less severe than the SBS, with cool wet winters and warm dry summers. The major tree species are western and mountain hemlock, balsam and amabilis fir, hybrid white spruce, lodgepole pine, trembling aspen, black cottonwood and paper birch.

Two coastal zones also spill over the mountains into the Bulkley TSA in limited occurrences: the Coastal Western Hemlock (CWH) zone at lower elevations and the Mountain Hemlock (MH) zone at higher elevations. In the CWH, western and mountain hemlock, lodgepole pine, balsam and amabilis fir, hybrid white spruce and black cottonwood are the main tree species. In the MH zone, western and mountain hemlock, amabilis and subalpine fir, and whitebark pine are the most common species.

The Bulkley TSA contains high-quality recreational fishing sites, including three internationally and provincially significant rivers (the Babine, Bulkley and Zymoetz or Copper). These rivers and their tributaries provide important migration routes and spawning habitat for steelhead trout and for sockeye, Chinook, pink and coho salmon. The TSA borders on the west arm of Babine Lake, which has the largest recreational sports fishery in the region. Angling is also popular in smaller lakes in the TSA, particularly for Dolly Varden char and cutthroat trout.

The TSA hosts an abundance of wildlife including grizzly bear, mountain goat, deer and moose. The Babine River watershed supports a provincially significant population of grizzly bears. The Telkwa Caribou Herd Recovery Area provides protection to the only remaining herd of local caribou through special management measures, landscape corridors and core ecosystem areas.

The majority of species that are considered at risk or regionally significant and that occur or potentially may be found in the Bulkley TSA are presented in Table 1.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

Table 1. Vulnerable, endangered and threatened species

Endangered or threatened (red-listed)	Vulnerable (blue-listed)	
Swainson's hawk	Short-eared owl	*luscus* wolverine
American peregrine falcon	American bittern	fisher
giant pygmy whitefish	trumpeter swan	grizzly bear
	bull trout	

Source: B.C. Conservation Data Centre, November 1, 1998.

Current forest management practices follow the standards set out by the *Forest Practices Code*. In addition, the Bulkley Land and Resource Management Plan (LRMP) provides four levels of management direction: general management direction, resource management zones, ecosystem network and enhanced timber development areas, and planning unit management direction.

General management direction

This is provided through 11 categories (biodiversity*, access, timber, water quality, fish and wildlife habitat, visual quality, range management, outdoor recreation and tourism, sub-surface resources, cultural heritage resources*, and future planning processes).

Resource management zones (RMZ)

The land base is divided into six zones: Protected, Special Management 1 and 2, Integrated Resource Management, Settlement, and Agriculture/Wildlife.

Ecosystem network and enhanced timber development areas

An ecosystem network extends throughout the TSA and includes both core ecosystems (e.g., representative areas of ecosystems and old-growth forests) and landscape corridors which maintain connectivity, reduce habitat fragmentation, and permit movement of animals. Enhanced timber development areas have been established on productive sites with gentle slopes where there is little conflict with other values or uses. These areas are managed under intensive silvicultural practices to enhance timber supply and quality.

Planning unit management direction

The LRMP guides the development of more detailed planning by subdividing the TSA into 12 planning units that approximate landscape units. Landscape unit plans provide more explicit direction to operational plans to meet requirements for biodiversity and non-biodiversity values.

1.2 First Nations

The Gitxsan, the Wet'suwet'en, the Nat'oot'en and the Tsimshian First Nations have traditional lands within the Bulkley TSA. Moricetown and Fort Babine are First Nations communities.

All of the First Nations have submitted comprehensive land claims covering portions of the Bulkley TSA. The Gitxsan claim is at the stage of bilateral negotiations, the Wet'suwet'en and the Tsimshian have reached agreements-in-principle, and the Nat'oot'en have reached a framework agreement. When the land claims have been settled, they will be considered in future timber supply reviews.

Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

Cultural heritage resource
An object, a site or the location of a traditional societal practice that is of historical, cultural or archaeological significance to the province, a community or an aboriginal people.

1 Description of the Bulkley Timber Supply Area

All of the First Nations have expressed concerns about timber harvesting in their traditional territories. Traditional Use Studies are complete for about 50% of the TSA, carried out by the Wet'suwet'en Nation within their traditional territories. However, these studies were not available in time for consideration in this timber supply analysis. Studies in Gitxsan territory are underway.

Since 1995 the forest district has been working on a Cultural Heritage and Archeological Resource Inventory (CHARI), at a mapping scale appropriate for operational use. This inventory identifies known archaeological sites and traditional use areas (including some trails), and predicts the likely locations of other sites. The results of this inventory were not available for inclusion in this timber supply analysis.

In addition, Archaeological Impact Assessments (AIAs) are done as part of operational planning. The district manager established a culturally modified tree (CMT)* policy in 1999. This has increased awareness of cultural heritage features, and when used in combination with CHARI should lead to more frequent recommendation and completion of AIAs. These assessments will aid in the development of a more accurate predictive model for future updates. The effects of this CMT policy will be considered in the next timber supply analysis.

Culturally modified tree
A tree or a remnant of a tree with evidence of traditional aboriginal forest use.

2 Information Preparation for the Timber Supply Analysis

Timber supply analysis requires three general categories of information: land base inventory; timber growth and yield; and management practices. These three categories are discussed below. Also, in preparation for the analysis, a number of changes since the 1993 Bulkley TSA timber supply analysis were noted, and are described in Section 2.4, "Changes since the 1993 Bulkley TSA analysis."

2.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled in 1998 by the B.C. Forest Service. This file contains information on the forest land in the Bulkley TSA including general geographic location, area, nature of forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other characteristics such as environmental sensitivity and physical accessibility (operability*). Stand attributes such as tree height, stocking* and age have been projected to 1998. The inventory file has been updated to account for timber harvesting up to 1994 for the Bulkley TSA.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, areas in utility and transportation corridors, and residential and industrial development. A description of these areas specific to the Bulkley TSA is provided below. These types of areas do not contribute to the timber harvesting land base* of the Bulkley TSA. Before assessing timber supply, these non-contributing areas are identified and separated from the timber harvesting land base.

Identifying areas as not contributing to timber supply does not mean the area is removed from the Bulkley TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein is consistent with this philosophy.

This section describes the types of areas that do not contribute to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites of adequate environmental resilience, to accommodate timber harvesting with due care for other resources.

For the Bulkley TSA, the following types of areas were excluded from the timber harvesting land base.

- not managed by the B.C. Forest Service — these are non-Crown areas, such as private land, Indian Reserves, woodlot licences* and parks which are removed from the TSA. The forested portions of parks and ecological reserves are included in this analysis since they contribute towards biodiversity values.
- non-forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).

Operability
Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

Timber harvesting land base
Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Woodlot licence
An agreement entered into under the Forest Act. *It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.*

- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- inoperable areas* — staff in the Bulkley/Cassiar Forest District and major licensees within the Bulkley TSA have developed a harvest method mapping (HMM) system to classify all Crown forested area within the TSA. This HMM system is described in more detail in the data package published for this TSA. In the HMM system, inoperable areas are characterized by slopes greater than 90%.
- terrain stability — areas identified on terrain stability maps as having high potential for landslides following timber harvesting or road construction. This mapping was available only for the Copper landscape unit.
- riparian area* — area otherwise available for timber production, a portion of which is assumed to be unavailable for harvesting to provide protection for riparian and stream ecosystems.
- helicopter areas — these are areas with slopes between 60 to 90% and may be suitable for logging using helicopters.
- cable areas — under the HMM system, these are areas with slopes between 35 to 60% which may be suitable for logging using cable equipment.
- sites with low timber productivity — forest growing in these areas are projected to have a volume of less than 150 cubic metres per hectare by age 160 years.
- problem forest types (PFT) — stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability, including deciduous*-leading stands.
- existing unclassified roads, trails and landings (RTLs) — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- recreation areas — areas which are deemed to be of high recreational value.
- environmentally sensitive areas (ESA)* — areas with sensitive soils or where there may be difficulty regenerating a new crop of trees.
- newly created parks — these areas were removed from the timber harvesting land base.
- special management zone 1 — these are resource management zones which were established as a result of LRMP and have been removed from the timber harvesting land base.

A more detailed description of these categories, including specific criteria for removal is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas in each category, and shows the area of the timber harvesting land base. The column "Crown forest area by classification" provides the total forested area managed by the B.C. Forest Service within the given category. For example, while there is a total of 63 669 hectares of forested land classified as environmentally sensitive area (ESA), only 9499 hectares were removed specifically due to environmental sensitivity. The difference arises because one area can be in more than one classification (e.g., cable areas and ESA), and the actual area deducted depends on the point at which the reduction occurs in the sequence.

Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Deciduous
Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.

Table 2. Determination of the timber harvesting land base for the Bulkley TSA

Classification	Crown forest area by classification	Area (hectares)	Per cent of total TSA area	Per cent of Crown forest area
Total TSA area		762 540	100	
Not managed by the B.C. Forest Service		95 232	12.5	
Non-forest and non-productive area		171 386	22.5	
Total forested area managed by the B.C. Forest Service (Crown forest)[a]		**495 922**	**65**	**100**
Reductions to Crown forest:				
Non-commercial cover (brush)	6 312	6 312	0.8	1.3
Inoperable	348	348	0.0	0.1
Terrain stability in Copper LU	1 729	1 698	0.2	0.3
Riparian areas	54 900	10 932	1.4	2.2
Helicopter areas	7 695	7 388	1.0	1.5
Cable areas	32 109	31 320	4.1	6.3
Low productivity sites	45 768	44 551	5.8	9.0
Problem forest types	40 125	19 020	2.5	3.8
Existing roads, trails, and landings	8 340	8 340	1.1	1.7
Recreation areas	1 210	696	0.1	0.1
Environmentally sensitive areas	63 669	7 836	1.0	1.6
Newly created parks	11 537	9 499	1.2	1.9
Special management zone 1	18 342	8 108	1.1	1.6
Total current reductions		156 048	20.5	31.5
Current timber harvesting land base (includes 8994 hectares not satisfactorily restocked (NSR)*[b]		**339 874**	**44.6**	**68.5**
Future reductions				
Future roads		15 763	2.2	3.4
Agricultural land reserves[c]		4 841	0.6	0.9
Future timber harvesting land base		**319 270**	**41.9**	**64.4**

(a) This analysis includes an additional 10 164 hectares of forested area, mostly from provincial parks, not managed by the B.C. Forest Service. Although this area does not contribute to timber supply, this forest contributes to non-timber objectives such as the requirement for biodiversity.

(b) Not satisfactorily restocked areas include current and backlog areas.

(c) Agricultural land reserves (ALR) will be harvested over the next 70 years and removed from the timber harvesting land base.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well-spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

2 Information Preparation for the Timber Supply Analysis

Figure 2 represents the total Bulkley TSA and the Crown forested land base. The chart shows that about 12.5% of the total land base is classified as not managed by B.C. Forest Service, and 22.5% is classified as non-forest or non-productive forest (i.e., having very few trees). The Crown forested area chart details the categories of forest land and shows that about 31.5% of the forest land in the Bulkley TSA is considered to be unavailable for harvesting. The main reasons for unavailability are low site productivity, steepness of terrain (cable and helicopter areas), and problem forest areas. Approximately 68.5% of the Crown forested area is considered available for timber harvesting (including not satisfactorily restocked (NSR)).

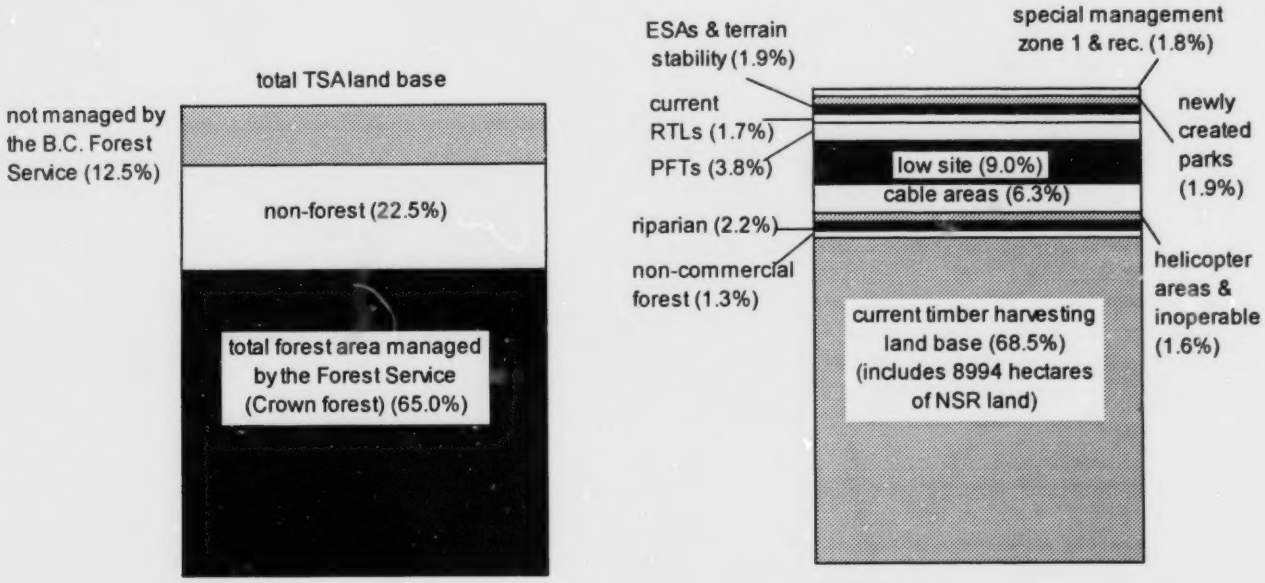
total TSA land base
not managed by the B.C. Forest Service (12.5%)
non-forest (22.5%)
total forest area managed by the Forest Service (Crown forest) (65.0%)
ESAs & terrain stability (1.9%)
special management zone 1 & rec. (1.8%)
current RTLs (1.7%)
PFTs (3.8%)
low site (9.0%)
cable areas (6.3%)
newly created parks (1.9%)
riparian (2.2%)
non-commercial forest (1.3%)
helicopter areas & inoperable (1.6%)
current timber harvesting land base (68.5%) (includes 8994 hectares of NSR land)

Figure 2. Composition of the total and Crown forested land bases — Bulkley TSA, 2001.

2 Information Preparation for the Timber Supply Analysis

Figure 3 and Table 3 show the distribution of biogeoclimatic (BEC) variants in the total forested area (Crown forested area plus the forested portions of parks) and in the timber harvesting land base. Also shown is the proportion of each BEC variant that is outside of the timber harvesting land base. For example, the ESSFmc variant makes up 33.2% of the total forested area and 30.5% of the timber harvesting land base, while 37% of the total area of ESSFmc is outside of the timber harvesting land base. The numbers in the last column of Table 3 suggest that, except for the ESSFmc, the forest outside the timber harvesting land base may be sufficient to meet old-seral* requirements in the longer term if it is well–distributed among the landscape units and is allowed to grow undisturbed.

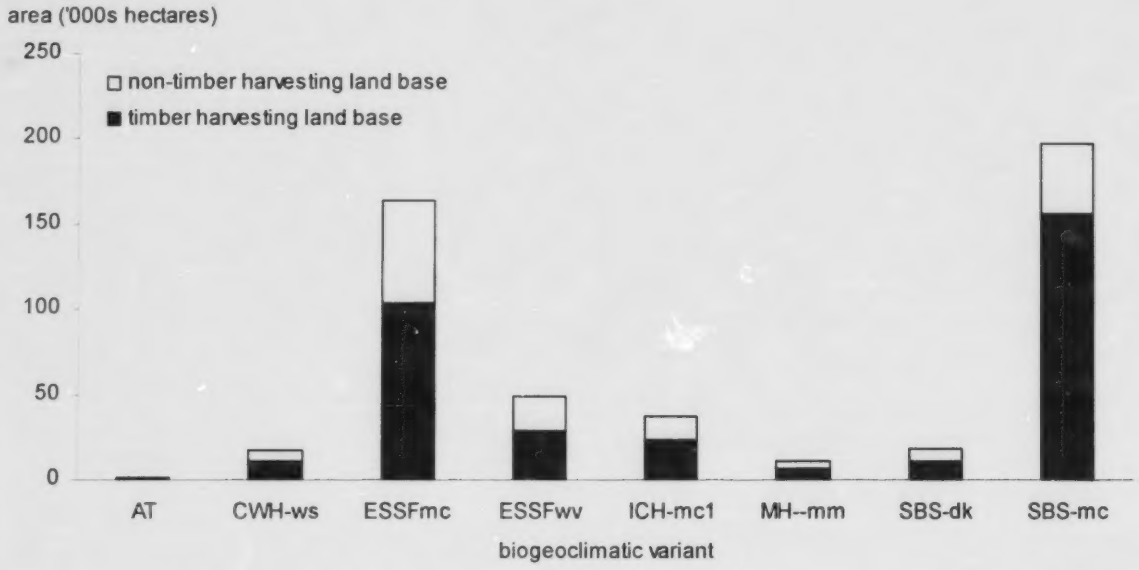

Figure 3. Area by biogeoclimatic classification — Bulkley TSA, 2001.

Old seral
Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.

Table 3. Summary of biogeoclimatic zone areas — Bulkley TSA, 2001

Biogeoclimatic ecosystem classification (BEC) zone/variant	Per cent of total forested area in BEC variant	Per cent of timber harvesting land base in BEC variant	Per cent of BEC variant outside the timber harvesting land base
AT	0.2	0.1	75
CWHws	3.3	3.1	35
ESSFmc	33.2	30.5	37
ESSFwv	9.9	8.3	42
ICHmc	7.4	7.0	35
MHmm	2.2	1.9	40
SBSdk	3.7	3.0	45
SBSmc	40.1	46.2	21
Total	100	100	Not applicable

2 Information Preparation for the Timber Supply Analysis

Figure 4 shows the current composition of the timber harvesting land base by dominant tree species. Sub-alpine fir (balsam) species dominate stands on about 48% of the timber harvesting land base, with pine dominating on 25%, and spruce 23%. After harvest, most stands are expected to be regenerated to the same species, except for hemlock and balsam sites, which will be planted to spruce and pine along with some natural regeneration of hemlock and balsam respectively.

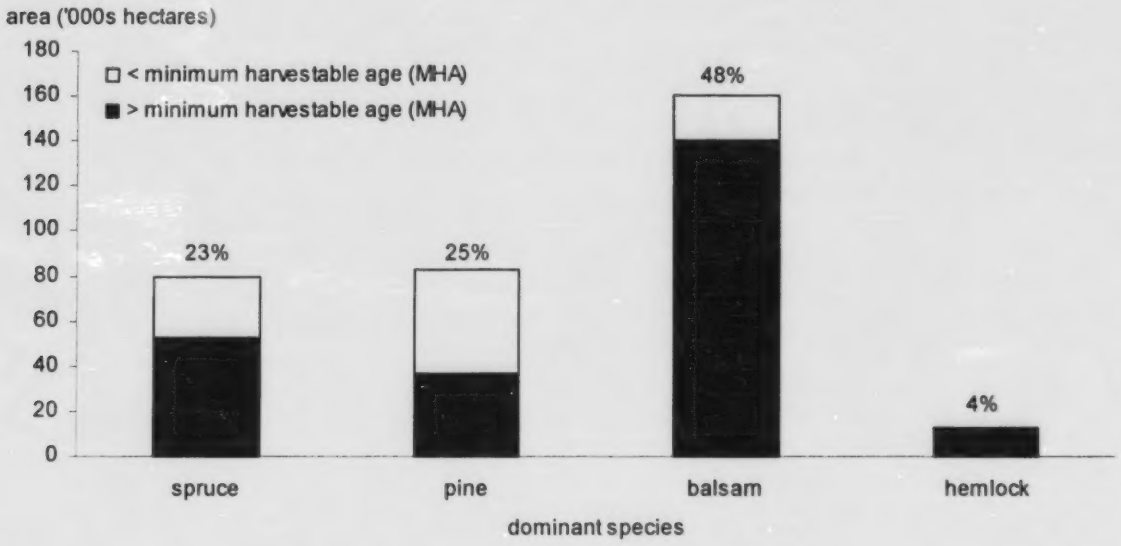

Figure 4. Area by dominant species — Bulkley TSA timber harvesting land base, 2001.

Figure 4 also shows the proportion of area of each species that is either younger or older than the minimum harvestable age (MHA) (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for details on the minimum harvestable age for each species). In total, about 72% of stands in the timber harvesting land base are at or above the minimum harvestable age. There is variation around this proportion for each of the species groupings: 88% of balsam stands, 93% of hemlock stands, 44% of the pine stands and 66% of spruce stands are currently older than the minimum harvestable age.

Given the different proportions of area below minimum harvestable age for each species group, it would appear that harvesting and salvage operations in the Bulkley TSA have concentrated mostly on pine and spruce. As noted previously, hemlock and balsam stands have been converted to pine and spruce stands, which adds immature area to these categories.

Figure 5 shows the distribution of site productivity of the dominant stand types within the timber harvesting land base. Twenty-four per cent of the stands are classified as having relatively good site productivity. Stands with medium site productivity occupy 61% of the area, and those with a relatively poor site productivity, 15%. Young stands of very low productivity (not capable of producing 150 cubic metres per hectare by age 160 years) were excluded from the timber harvesting land base. Stands older than 160 years which have a volume greater than 150 cubic metres per hectare were not removed from the timber harvesting land base on the basis of site productivity. Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" contains a definition of good, medium and poor site productivity for each of the species groups shown in Figure 5.

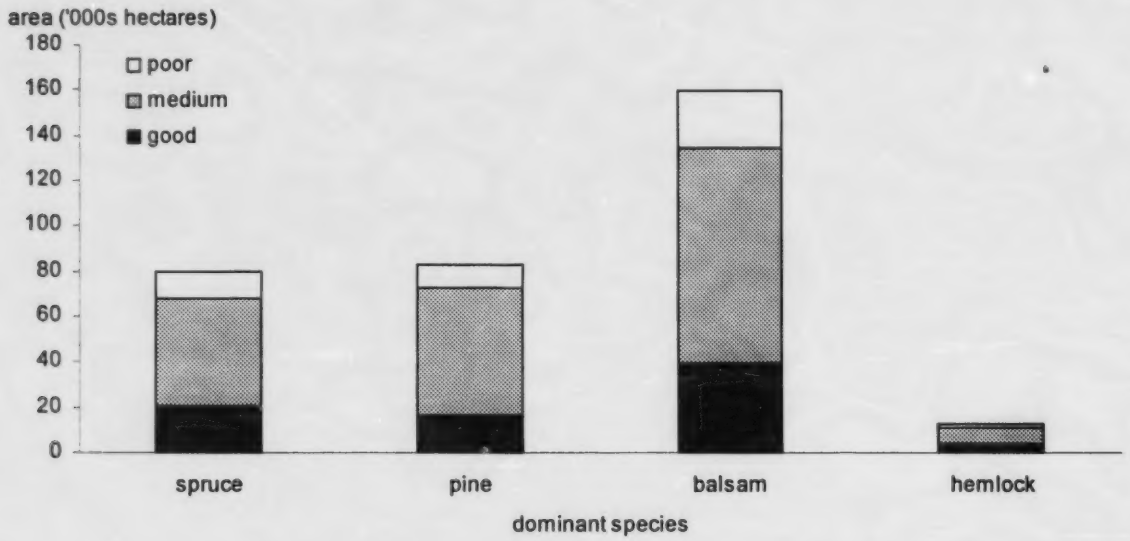

Figure 5. Area by dominant species and site productivity — Bulkley TSA timber harvesting land base, 2001.

2 Information Preparation for the Timber Supply Analysis

Figure 6 shows the current age composition of forested stands in the Bulkley TSA. About 31% of the timber harvesting land base is occupied by stands older than 250 years. About 12% of the area is covered with stands 20 years or younger, 13% is between 21 and 100 years old, and 44% is between 101 and 250 years of age. Almost 72% of the timber harvesting land base is covered with stands at or above the minimum harvestable age applicable to the stand.

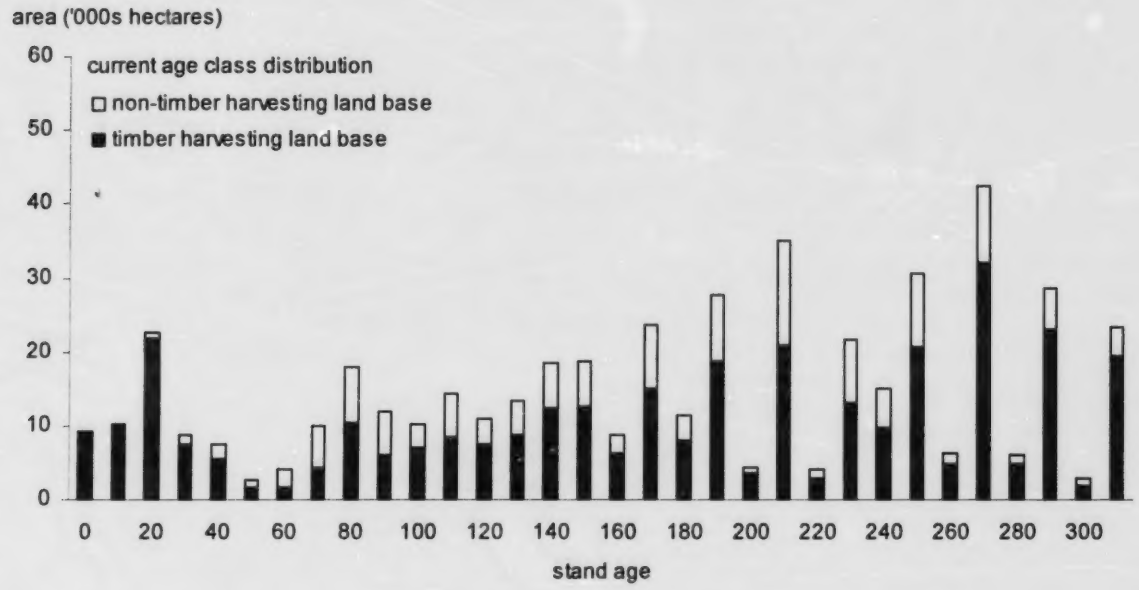

Figure 6. Current age class composition — Bulkley TSA forested land base, 2001.

The age class distribution of forested stands excluded from the timber harvesting land base also affects timber supply. Although they do not contribute directly to timber supply, these areas can affect how much harvesting can be conducted and the pattern of the harvesting within the TSA by providing old-forest and biodiversity attributes. The total forested land base in the Bulkley analysis area, which includes some land not managed by the B.C. Forest Service, is approximately 491 000 hectares. A significant portion of the total forest area — 31% — does not contribute to the timber harvesting land base. About 23% of these "non-timber harvesting land base" stands are older than 250 years. Only 1% of the stands are 20 years or younger, 20% are between 21 and 100 years old, and 56% are between 101 and 250 years of age.

In the longer term, the non-timber harvesting land base may be able to provide most of the area needed to meet old-forest biodiversity requirements provided this forest is allowed to age without disturbance and is well distributed among the landscape units in the Bulkley TSA.

2.2 Timber growth and yield

Two growth and yield models were used to estimate timber volumes for the Bulkley TSA analysis. The variable density yield prediction (VDYP) model* developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in unmanaged coniferous* stands. The table interpolation program for stand yields (TIPSY)*, developed by the B.C. Forest Service, Research Branch, was used to estimate yields for coniferous managed stands. TIPSY was also used to estimate yields from stands that were harvested during the past forty years but managed to current standards. Stands harvested more than forty years ago are considered unmanaged.

Timber volume estimates* assume a specific utilization level, or set of dimensions, which establish the minimum sizes of trees and logs that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree as well as a maximum stump height.

Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" contains details on the definition of managed stands, utilization standards and the specific model versions used.

Volume estimation and prediction are subject to uncertainty due to uncertainties in inventories which form the basis for estimating site productivity, limited experience with second-growth in British Columbia, and the long time frame over which trees grow. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates, the current timber inventory on the timber harvesting land base is approximately 79.8 million cubic metres. About 72.8 million cubic metres, or 91% of the total, are currently merchantable; that is, older than minimum harvestable age.

2.3 Management practices

Timber supply depends directly on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis process. The *Forest Practices Code of British Columbia Act* and associated regulations guide forest management practices in the Bulkley TSA. The focus of the timber supply review is to assess timber supply based on current management practices as implemented for the area. Current management is described in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis"). Staff in the Bulkley/Cassiar Forest District provided descriptions for the following management practices:

- Silviculture — reforestation activities required to establish free-growing* stands of preferred and acceptable tree species. Most areas in the Bulkley TSA are harvested using a clearcut harvesting* system and restocked by planting or natural regeneration.

Variable Density Yield Prediction model
An empirical yield prediction system supported by the B.C. Forest Service, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed composition.

Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.

Table Interpolation Program for Stand Yields
A B.C. Forest Service computer program used to generate yield projections for managed stands using a model that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.

Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Clearcut harvesting
A harvesting method in which all trees are removed from an area of land in a single harvest. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding. Note that retention of some live trees and snags for purposes of biodiversity now occurs on most clearcuts.

- Forest health and unsalvaged losses* — timber losses to fire and pest (insect) damage are expected to average 69 035 cubic metres per year over the 250 year analysis horizon.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.
- Cutblock adjacency* and green-up* — in the Bulkley TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (three metres in height for integrated forest management area), before adjacent stands may be harvested. The purpose of the cutblock adjacency guideline is to prevent timber harvesting from becoming overly concentrated in an area. These guidelines were modelled by limiting the area within the integrated resource management (IRM)* zones that does not meet green-up conditions to a maximum of 33%.
- Maintenance of scenic values — maintaining important scenic values requires that visible evidence of harvesting must be kept within limits in some areas of the Bulkley TSA. The maximum proportion of each scenic area* that may be covered by young stands that do not meet green-up requirements (five metres in height) varies depending on the forest characteristics, the visual quality objectives (VQO)* and the visual absorption capability (VAC) for each area, ranging between 1% and 25%.
- Maintenance of Babine Special Resource Management zone (SMZ) — a minimum of 30% of the forested area in this zone is always maintained in stands that are more than 140 years old.
- Protection of environmentally sensitive areas — areas where sensitive soils, recreation values and forest regeneration problems have been identified. To maintain ecological or other valuable resource values, land has been partially or wholly removed from the timber harvesting land base.
- Community watersheds — within designated watersheds a maximum of 5% of the forested area may be harvested within a 5-year period, as suggested by the *Forest Practices Code Community Watershed Guidebook*. Community watersheds cover 3.8% of the timber harvesting land base.

Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

Integrated resource management (IRM)
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Scenic area
Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Visual quality objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

- Minimum harvestable ages (MHA) — the time it takes for stands to grow to a merchantable condition. Spruce and pine stands were considered merchantable when they attained a volume of 150 cubic metres per hectare and the stems averaged a breast height diameter of 25 centimetres. Balsam and hemlock stands were not merchantable until they attained a volume of 175 cubic metres per hectare and the same average stem diameter as for spruce stands. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other available stands, forest cover objectives* and overall timber harvest targets.
- Landscape-level biodiversity* — to maintain biological diversity throughout a landscape unit, the *Forest Practices Code* specifies targets for the proportion of the area in each biogeoclimatic variant* that should be covered by stands with old-forest characteristics. Within the Bulkley TSA, old forest is characterized by stands greater than 250 years old except in the sub-boreal spruce biogeoclimatic zone where old-forest characteristics are exhibited at 140 years old. Since biodiversity emphasis options were still draft, a weighted average old-seral requirement was applied in the analysis (see Section A.4.9, "Forest cover requirements" in Appendix A).
- Grizzly bear and caribou habitat — these areas were protected by ensuring that at least 50% of the identified habitat area was covered by forest greater than 80 years for grizzly or 90 years for caribou.
- Landscape corridors — were identified to maintain landscape connectivity and reduce habitat fragmentation. At least 70% of the timber harvesting land base in this area was required to have forest greater than 80 years old.
- Core ecosystems — core ecosystems retain a cross-section of ecosystems and samples of old-growth forest across the landscape. No more than 5% of the timber harvesting land base in this area was allowed to have forest less than 50 years old.

The data package for the Bulkley Timber Supply Area (TSA) was released in June 1998. As a result of public input, changes were made to the data package (e.g., revision of roads, trails and landings calculation). The revised data package, which includes detailed descriptions of the management practices and the assumptions used to incorporate them into the analysis, is presented in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" of this document.

Forest cover objectives
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see ***Cutblock adjacency*** *and* ***Green-up****).*

Landscape-level biodiversity
The Landscape Unit Planning Guide *provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.*
Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.

2 Information Preparation for the Timber Supply Analysis

Figure 7 shows the proportions of the timber harvesting land base according to the forest management objectives for those areas. The total area shown in the bar chart exceeds the timber harvesting land base by almost 8%. This is because more than one management objective may be applied to the same area; for example, part of the special management two zone may also be managed for landscape corridors. An area managed for an objective such as wildlife habitat includes non-timber harvesting land base as well as timber harvesting land base. The percentages shown in Figure 7 are only for the timber harvesting land base portion of that management objective.

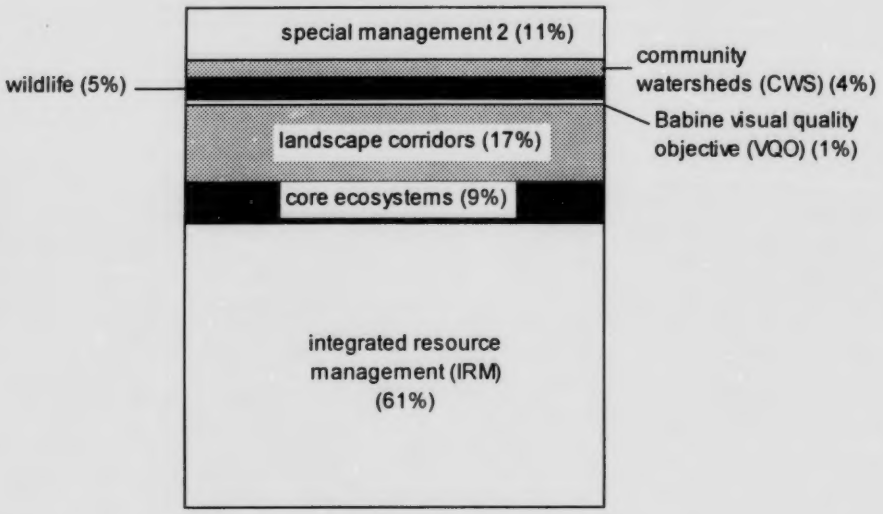

Figure 7. Timber harvesting land base by management emphasis — Bulkley TSA timber harvesting land base, 2001.

2.4 Changes since the 1993 Bulkley TSA analysis

The objective of this section is to present the major changes to the land base and forest management assumptions since the last analysis.

- In the last analysis the forested area managed by the B.C. Forest Service was 479 445 hectares. It is now 495 922 hectares, mostly due to the reclassification of non-forest types.
- The timber harvesting land base is approximately 62 000 hectares larger in this analysis. This is due partly to the refinement of the land classification system (harvest method mapping) implemented in the TSA, and partly to the re-inventory of the TSA in 1997.
- Implementation of the Bulkley LRMP has increased forest cover constraints on the timber harvesting land base by adding core ecosystems, landscape corridors, visually sensitive areas, wildlife areas and special management zones.
- Implementation of the *FPC* has increased land base reductions for riparian reserves and management zones. Stand-level biodiversity* is accommodated through the retention of wildlife tree* patches. In this analysis the effect of wildlife tree patch retention was modelled by reducing the volume curves rather than removing forested land. Additional constraints which also often limit the availability of the timber harvesting land base are the requirements to maintain (or recruit) suitable areas of old forest for landscape-level biodiversity. Community watersheds were also modelled in this analysis.
- The use of yield curves generated using TIPSY for all managed stands in this analysis has a significant effect on the timber supply forecast. Managed stands yield curves tend to project yields which are 20-25% greater than yields projected by yield curves generated using VDYP.

In summary, the timber harvesting land base has increased by 22% and some modelling assumptions have changed since the last analysis. Given the extent of these changes, direct comparisons between this and the previous analysis cannot be made. Each analysis needs to be evaluated in the context of the management regime and related data inputs and assumptions that applied at the time. As noted in the introductory section, there is uncertainty surrounding information used in analyses, and forest management objectives change over time, which is why the *Forest Act* requires the chief forester to review the timber supply and AAC for each TSA periodically.

Any changes to the land base or management assumptions that occur or become effective after the completion of this timber supply analysis will be presented to the chief forester for consideration during the AAC determination, if possible.

Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Bulkley TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service (FSSIM version 3.0) was used to aid in the assessment. A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in determining how a whole forest (collection of stands) could be managed to obtain a harvest forecast* (supply of timber over time). The simulation model uses information about the timber harvesting land base, timber volumes and the management regime to represent how trees grow and are harvested over a long period of time. Generally, only the results for the first 250 years are shown graphically in this report because the harvest level remains constant after that time.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst. The Forest Service model also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of green-up and old-forest prescriptions. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model facilitates examination of the effects of such guidelines on timber supply.

This type of analysis is used to determine the timber supply implication of a particular management regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although this information gives field staff only limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports sustainable forest management in the field.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

4 Results

This section presents results of the timber supply analysis for the Bulkley TSA. The base case harvest forecast* uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." The impacts of uncertainty in the inputs to the analysis will be discussed in Section 5, "Timber Supply Sensitivity Analyses." The base case provides only a part of the timber supply picture for the Bulkley TSA, and should not be viewed in isolation of the sensitivity analysis*.

Section 2.4, "Changes since the 1993 Bulkley TSA analysis," provides an overview of the major changes to the land base and management assumptions since the last analysis. As noted in that section, any comparison between this and the last analysis should be made with recognition of the extent and nature of those changes. Each analysis should be evaluated in the context of the management regime and related data inputs and assumptions that applied at the time. Finally, one of the major reasons the chief forester is required under the *Forest Act* to periodically review the timber supply and AAC is to account for changes in management, information and knowledge.

4.1 Base case harvest forecast

The base case harvest forecast for the Bulkley TSA represents current management as described in the various sections of Appendix A of this report. Figure 8 shows the base case harvest forecast for the Bulkley TSA. The initial harvest level is 882 000 cubic metres per year, which consists of the current AAC of 895 000 cubic metres per year, less 13 000 cubic metres per year that has been allotted to new woodlot licences. An annual harvest level of 882 000 cubic metres can be maintained for one decade before declining by 10% per decade to the long-term harvest level* of 554 945 cubic metres per year.

Base case harvest forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

Sensitivity analysis
A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.

Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

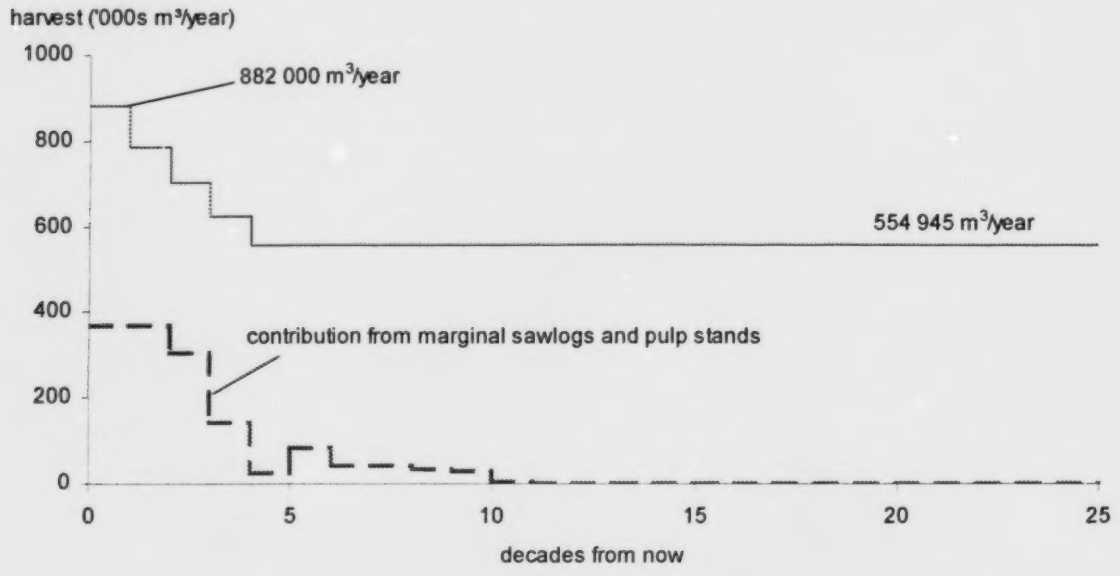

Figure 8. Base case harvest forecast — Bulkley TSA, 2001.

Also shown in Figure 8 is the contribution of marginal sawlog and pulplog stands to the base case harvest forecast. This analysis shows that these stand types can contribute 367 000 cubic metres per year for the first two decades and then rapidly declines to almost nothing by decade ten. A partition for marginal sawlog and pulpwood stands was defined in the 1995 determination and was set to 367 000 cubic metres per year. After harvesting, these areas are planted to spruce and pine species and are no longer considered marginal. Unsalvaged losses due to natural forces such as insects and fire are estimated to be 69 035 cubic metres per year for the entire 250-year horizon and have been subtracted from all harvest forecasts shown in this report.

4 Results

In the short- and medium-terms the harvest forecast for this TSA depends on the amount of currently existing timber growing stock*. Figure 9 shows a projection of timber inventory volumes over time corresponding to the base case harvest forecast. Total growing stock on the timber harvesting land base declines over the next 13 decades from 79.8 million cubic metres as the oldest of the existing mature stands are harvested and replaced by younger second-growth. Over the long term, the average total growing stock for the base case is about 50 million cubic metres.

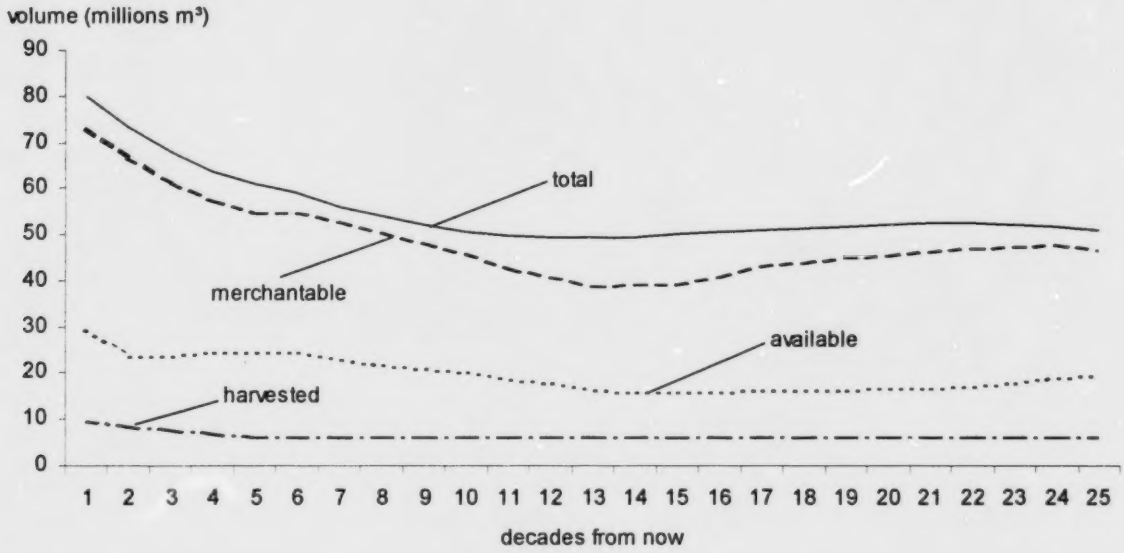

Figure 9. Total, merchantable and available growing stocks — Bulkley TSA, 2001.

About 72.8 million cubic metres, or 91% of the total growing stock, are currently merchantable; that is, older than minimum harvestable age. The average merchantable growing stock over the long term is about 47 million cubic metres. Even though timber may be merchantable it may not be available for harvesting because it is required to satisfy other resource requirements, such as caribou or grizzly habitat, as defined in Appendix A. The volume of timber currently available for harvest, while satisfying all the forest cover constraints imposed in this analysis, is about 29.6 million cubic metres. Available timber decreases to about 16 million cubic metres by decade 16 and then recovers to about 20 million cubic metres in the long term. Also shown on this graph is the volume of timber harvested in the base case. The difference between the volume harvested and the volume available gives an indication of the flexibility managers have in planning harvesting operations.

Growing stock
The volume estimate for all standing timber at a particular time.

4 Results

The base case long-term harvest level of 554 945 cubic metres per year is the harvest rate that can be achieved while maintaining the total timber growing stock on the timber harvesting land base at an even level, on average, over the long term. An even-growing stock indicates that harvesting can continue at the corresponding harvest level in perpetuity. A continually increasing growing stock would indicate that the timber is being harvested below the productive capability of the land. A continually declining growing stock would signify that the timber is being harvested above the productive capability of the land.

Figure 10 shows the transition of harvesting from existing to managed stands, and the amount that each makes up in the base case forecast. For the first nine decades the harvest depends fully on existing stands, and then during decades 10 through 12 the harvest becomes increasingly dependent on managed stands. The high volume of existing merchantable and available growing stock allows harvesting to occur in this TSA at the long-term level well before managed stands are harvested.

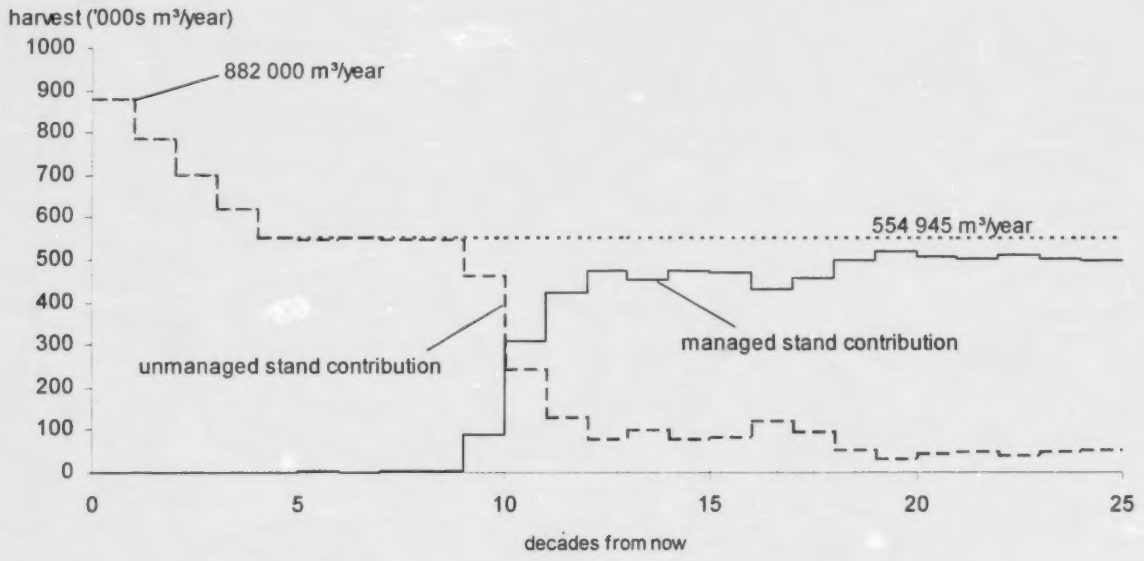

Figure 10. Harvest contribution from existing and managed stands — Bulkley TSA, 2001.

4.2 Average age, area, and volume harvested

Figure 11 tracks the change in the area-weighted average harvest age resulting from the base case forecast. Initially the harvest comes from the oldest stands in the timber harvesting land base. During the first 100 years of the forecast, the average harvest age is about 250 years. From decade 11 onward, managed stands comprise more of the forecast harvest, and the average age of the harvested stands declines to approximately 140 years. There are some areas of the TSA (VQOs, landscape corridors) where the rate of harvesting is very slow. This, combined with a harvest rule which schedules the oldest stands to be harvested first, can distort the area weighted average harvest age. Figure 11 also includes two lines showing all but the youngest 5% and the oldest 5% of harvested stands (by volume). These lines show the age range for most of the harvested stands (90% of the volume harvested).

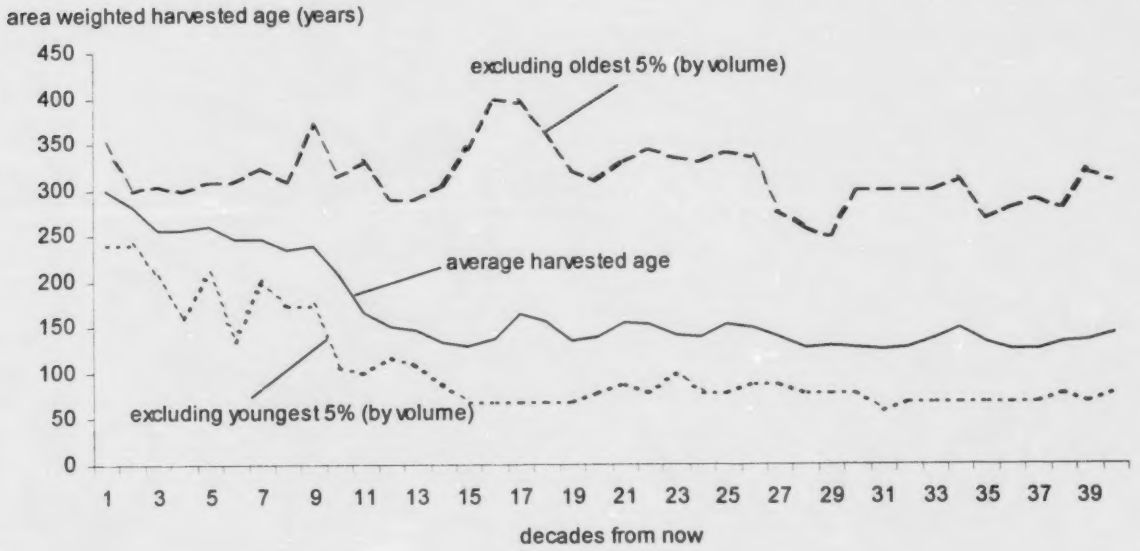

Figure 11. Average age of stands harvested over time — Bulkley TSA base case, 2001.

4 Results

Figure 12 shows the average volume per hectare and average area harvested per year over the next 400 years under the base case harvest forecast. For the first 10 decades, while the timber supply is forecast to come mainly from unmanaged stands, the average volume per hectare varies from 300 to 366 cubic metres per hectare. After decade 12 when the timber supply is forecast to come mainly from managed stands, the average volume per hectare gradually decreases to a low of 275 cubic metres per hectare during decade 18 before recovering to a long-term average of about 300 cubic metres per hectare. The area harvested for the first five decades decreases from approximately 3100 hectares per year to about 1900 hectares per year as the harvest level decreases (these areas have not been adjusted to account for the volumes deducted annually for non-recoverable losses (NRL)). The increase in the area harvested during decades 15 to 22 coincides with the lower volume stands being harvested at that time. In the long term, the average area harvested per year is about 2000 hectares.

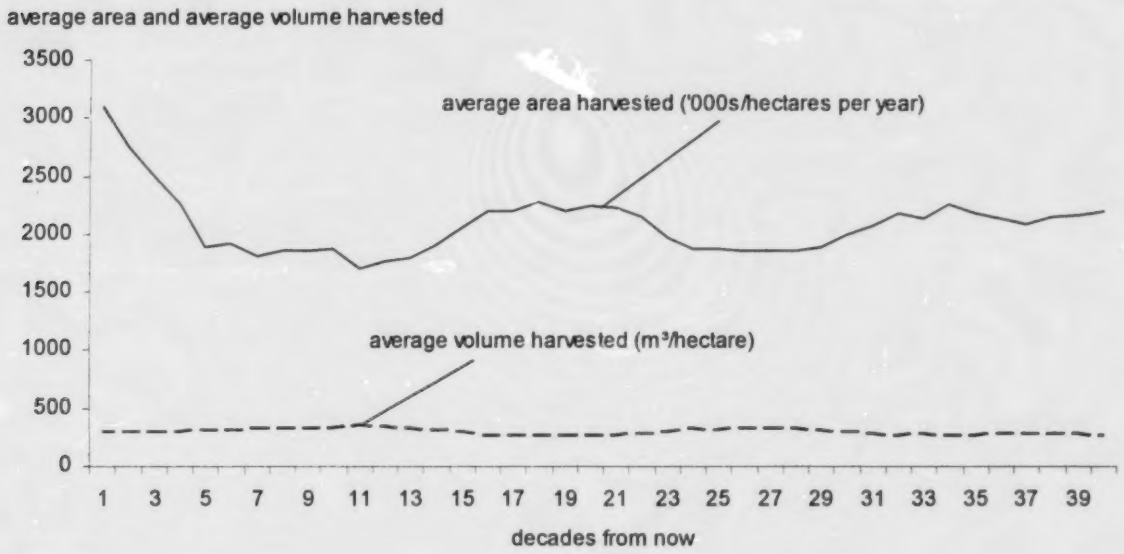

Figure 12. Average area harvested and average volume per hectare harvested over time — Bulkley TSA base case, 2001.

4.3 Age class profile over time

The charts in Figure 13 show how the age composition of the Bulkley TSA productive forest land base changes over the next 250 years under the base case harvest forecast.

There are approximately 491 000 hectares of productive forest land base within the Bulkley TSA analysis area, of which 339 874 hectares (70%) makes up the initial timber harvesting land base. The current age class distribution shows about 72% of stands within the timber harvesting land base at or above minimum harvestable age.
Thirty-one per cent of the timber harvesting land base is above 250 years of age and 33% is between 140 and 250 years of age.

The productive forest land base also contains stands that have been excluded from the timber harvesting land base. Outside of the timber harvesting land base 23% of the forested area is above 250 years of age and 46% of the stands are between 140 and 250 years old.

In addition to the forest excluded from the timber harvesting land base, a significant portion (25%) of the timber harvesting land base is comprised of core ecosystems and landscape corridors where the primary objectives are to maintain old-growth forest and landscape connectivity. To a large extent, this explains why even after 200 years of harvesting, the timber harvesting land base is projected to have 10% of its area above 250 years of age and 19% between 140 and 250 years old.

One consequence of having a large portion of the timber harvesting land base where the rate of harvesting is very slow is that the requirements for old- and mature-forest specifically to meet landscape-level biodiversity objectives do not further constrain timber supply beyond the base case levels.

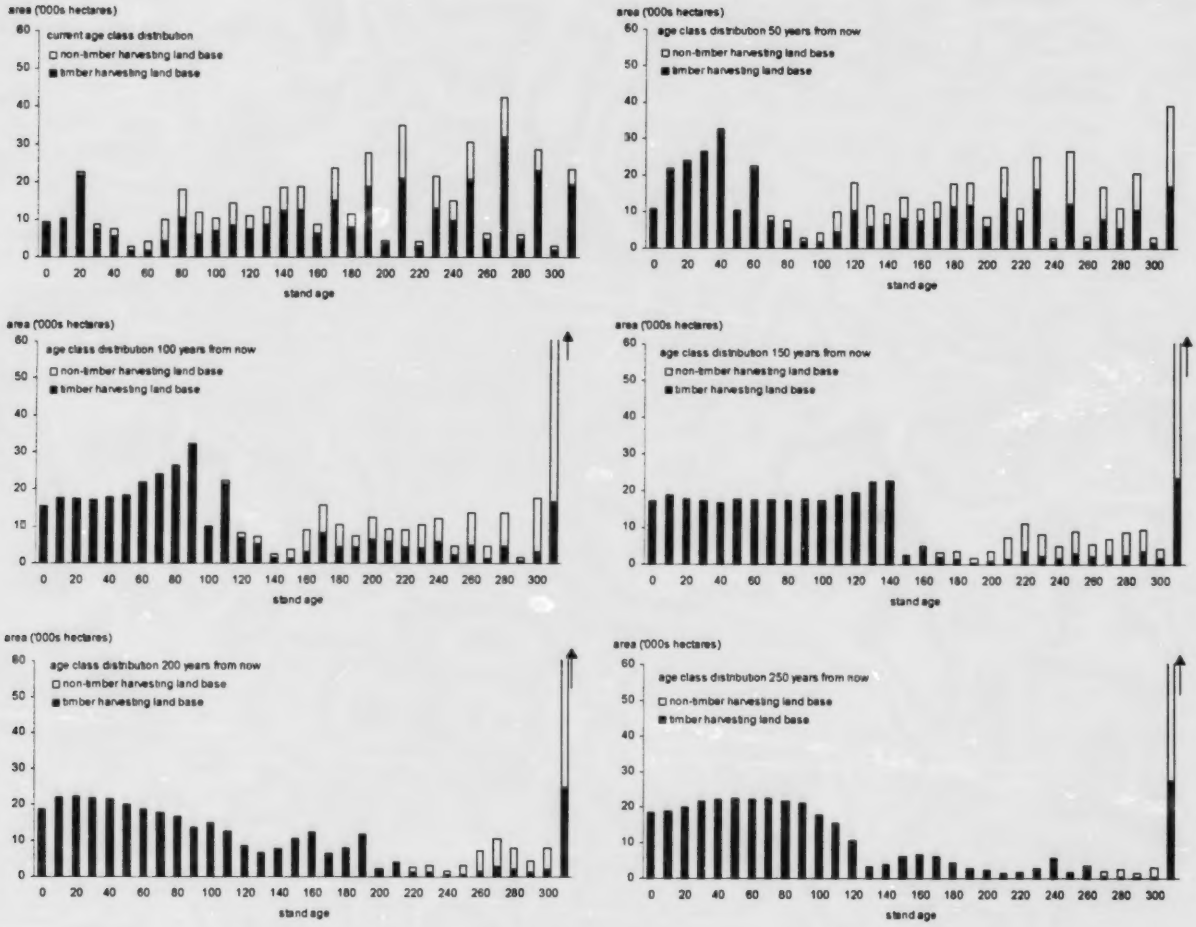

Figure 13. Changes in age composition on the productive land base over time — Bulkley TSA base case, 2001.

5 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices is used to analyse the timber supply implications of continuing with current management. However, forest management is complicated since it must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, so that decisions we make today have not only short-term but also long-term effects beyond the life spans of current decision makers. In such a context, we cannot be certain that all the data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed.

Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide a safe basis for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of several sensitivity analyses are discussed. Sensitivity analyses are intended primarily to test the relative change (i.e., high *versus* low sensitivity) in the harvest forecast resulting from changes in forest management assumptions and data used in the base case.

5 Timber Supply Sensitivity Analyses

5.1 Alternative harvest flows

The base case harvest forecast shown in Figure 8 was developed subject to several assumptions. For example, the initial harvest level was predetermined by the current allowable annual cut. The harvest level shown for marginal sawlog and pulplog stands was based on the current partition in the Bulkley TSA.

Figure 14 compares three alternative forecasts with the base case. In all forecasts, the harvest contribution from marginal sawlog and pulplog stands was not allowed to exceed 367 000 cubic metres per year. All inputs related to land base, growth and yield and management remain constant in all forecasts in Figure 14.

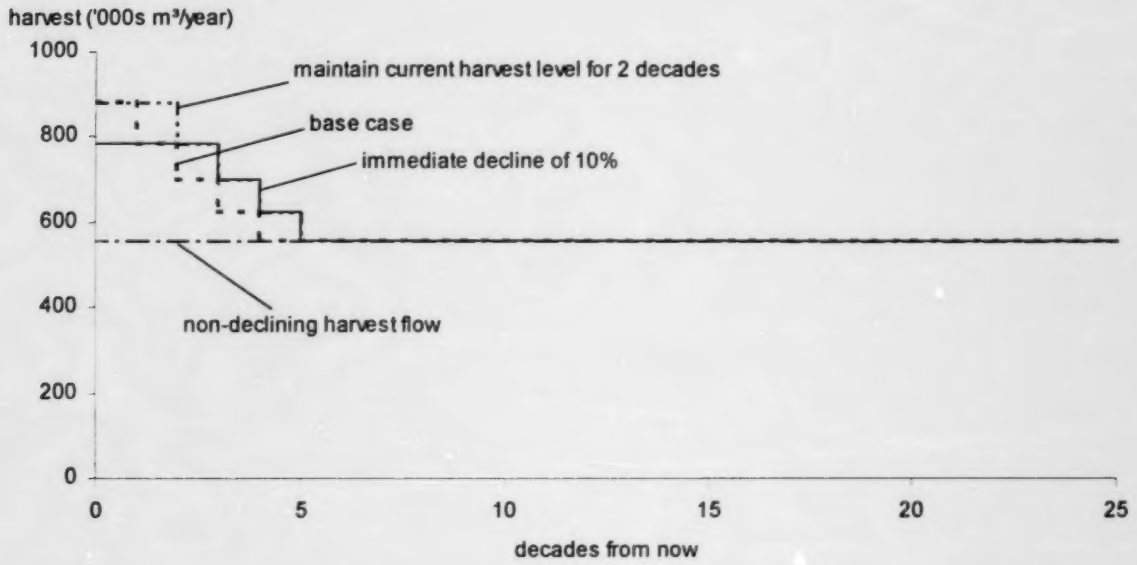

Figure 14. Alternative harvest forecasts — Bulkley TSA, 2001.

Maximum non-declining even-flow

- The non-declining even-flow harvest level of 554 945 cubic metres per year can be maintained for 400 years. This harvest level is the same as the long-term harvest level for the base case.
- This represents a 37% reduction in the short-term harvest level for the TSA.
- Managed, regenerated stands are projected to contribute significantly to the harvest starting at approximately decade 15, as compared to decade 10 in the base case.

Immediate decline of 10%

- Initial harvest level of 786 895 cubic metres per year can be maintained for 30 years before declining to the long-term level of 554 945 cubic metres per year.
- Total growing stock projections are similar to those resulting from the base case.

Maintain current harvest level for as long as possible

- It is possible to maintain the current harvest level for two decades before declining by 10% per decade to the same long-term harvest level as for the base case.
- Total growing stock projections are slightly lower than those resulting from the base case from decade 3 to the end of the planning horizon.
- Managed, regenerated stands are projected to contribute significantly to the harvest starting at approximately decade 9, as compared to decade 10 in the base case.

5.2 Uncertainty in the land base available for timber harvesting

Uncertainty in the estimated size of the timber harvesting land base is due to factors such as fluctuations in timber prices, changes in harvesting and milling technology and land-use decisions.

The timber harvesting land base has changed significantly since the last timber supply analysis for the Bulkley TSA. While the land base was reduced for factors such as new parks and riparian reserves, it has also increased significantly due to the refinement of the land classification system implemented in the TSA and the changes resulting from the 1997 re-inventory.

Currently there is no indication that the timber harvesting land base has been over- or underestimated. However, sensitivity analyses were performed to provide general information that might help evaluate the implications of any new information that becomes available before the AAC determination. The first analysis evaluates the outcome of removing the low site areas from the timber harvesting land and adding them to the "non-contributing" component. As currently defined, low site areas occupy 39 128 hectares or 11.5% of the timber harvesting land base. The second scenario evaluates the outcome of adding the areas identified as suitable for cable logging to the timber harvesting land base. These areas occupy 31 320 hectares, and if added will increase the timber harvesting land base by 9.2%. The harvest forecasts resulting from these changes are shown in Figure 15.

5 Timber Supply Sensitivity Analyses

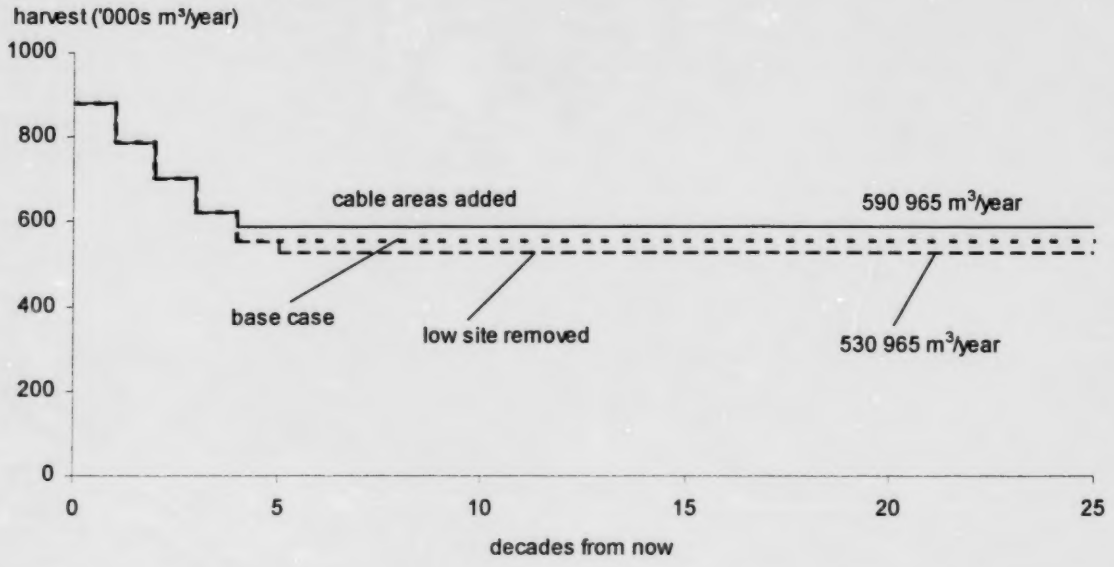

Figure 15. Land base sensitivity analysis — Bulkley TSA, 2001.

<u>If low site areas are removed from the timber harvesting land base (11.5% decrease in area)</u>

- Still sufficient area in older existing stands to support the base case initial harvest for one decade.
- Harvest flow similar to the base case for the first five decades.
- Long-term harvest level of 530 965 cubic metres per year, or 4.3% below the base case long-term level.

<u>If cable areas are added to the timber harvesting land base (9.2% increase in area)</u>

- Harvest flow similar to the base case for the first four decades.
- Long-term harvest level of 590 965 cubic metres per year, or 5.7% higher than the base case long-term level.

5.3 Uncertainty in the estimated existing stand yields

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the forest inventory used to estimate timber volumes (i.e., estimated tree heights and stand ages), and the statistical process used to develop the equations for predicting forest growth and yield. Timber volumes are normally accurate when averaged over large areas, but may not reflect actual volumes within individual stands. Uncertainty may also arise in the estimates of the volume lost both to decay in older trees, and to waste and breakage during harvest, and of the utilization levels practiced during harvesting. In addition, stand-level biodiversity requirements for the Bulkley TSA were addressed in this analysis through the removal of volume from each stand as it was harvested. Uncertainty may arise around the exact estimates of volumes left behind for stand-level biodiversity.

Inventory audit

During the last several years, Resources Inventory Branch has performed audits of the standing volume of trees within TSAs and TFLs across the province. These audits provide an indication of how confident we can be in estimated volumes in the management unit. For the Bulkley TSA, initial indications from the inventory audit were that standing volumes in operable stands over 60 years may be overestimated by approximately 12% when stems of 12.5 cemtimetres diameter at breast height (dbh) were considered merchantable (utilization level). When the utilization level was increased to 17.5 centimetres the audit indicated that standing volumes may be overestimated by approximately 9%. The utilization levels used in this analysis were 12.5 centimetres for marginal and pulplog quality stands, and 15 centimetres for all other stands, including all future regenerated stands. Resources Inventory Branch has recommended a more comprehensive study be conducted before any adjustments are made to the base inventory.

Given the uncertainties in existing stand volumes, the impacts of decreasing existing unmanaged stand yields (yield curves created through VDYP) by 12% were assessed. Figure 16 displays the results of this assessment as well as those of a standard sensitivity analysis where existing unmanaged stand volumes were increased by 10%.

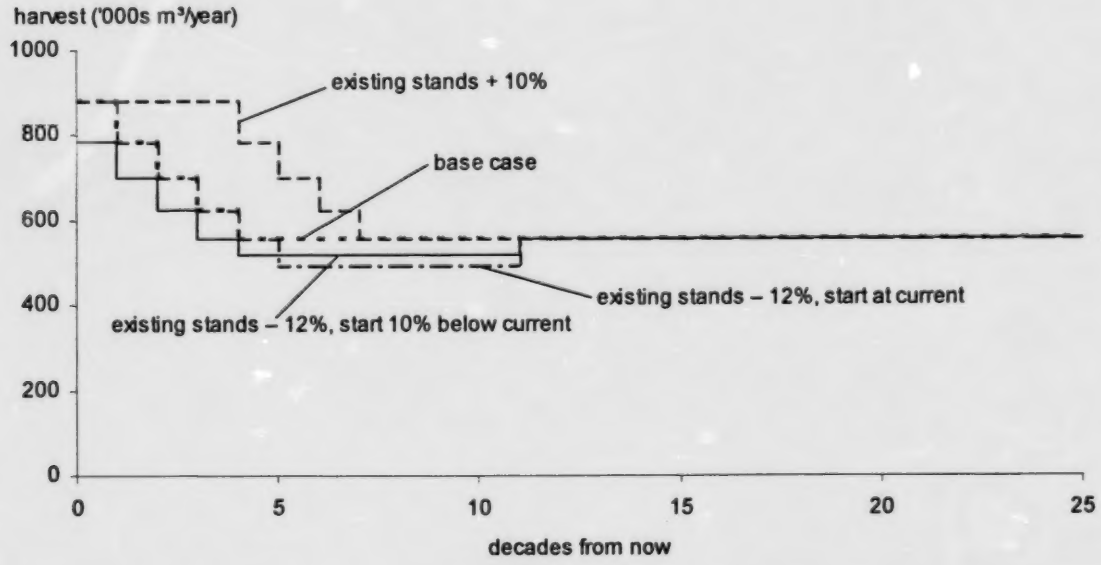

Figure 16. The effect on the harvest forecast of increasing and decreasing volume estimates for existing unmanaged stands — Bulkley TSA, 2001.

If existing unmanaged stand volumes are 12% lower than in base case, start at current

- Harvest forecast similar to the base case for the first five decades.
- The harvest forecast declines to 492 545 cubic metres per year, 11.2% below the base case level, during decades 6 to 11.
- After decade 11 the harvest forecast is the same as that in the base case.

If existing unmanaged stand volumes are 12% lower than in base case, start 10% below current

- The harvest forecast declines by 10% per decade for the first four decades.
- From decades 5 to 11 the harvest forecast is 520 965 cubic metres per year, 6.1% below the base case level.
- After decade 11 the harvest forecast is the same as that in the base case.

If existing unmanaged stand volumes are 10% higher than in base case

- A harvest level of 882 000 cubic metres per year can be maintained for four decades rather than for one decade as in the base case.
- After four decades, the harvest forecast declines by 10% per decade.
- The long-term harvest level is reached at the same time as the base case.

In summary, more work is necessary in the Bulkley TSA to determine whether the volumes from existing stands are accurate across the timber harvesting land base. If existing stand volumes are overestimated, the analysis shows that it is possible to maintain the current harvest level but mid-term harvest levels may have to be reduced by as much as 11%.

5.4 Uncertainty in the estimated managed stand yields

Uncertainty in volume estimates for managed stands exists for the same reasons listed for estimated existing stand yields (inaccuracies in the forest inventory and the growth and yield models), but also because of the limited experience and data that is available for regenerated managed stands in B.C. In this section, the timber supply effects of uncertainty associated with predicting volumes in regenerated stands is examined.

Figure 17 shows the harvest forecasts that result when regenerated stand volumes are increased and decreased by 10%.

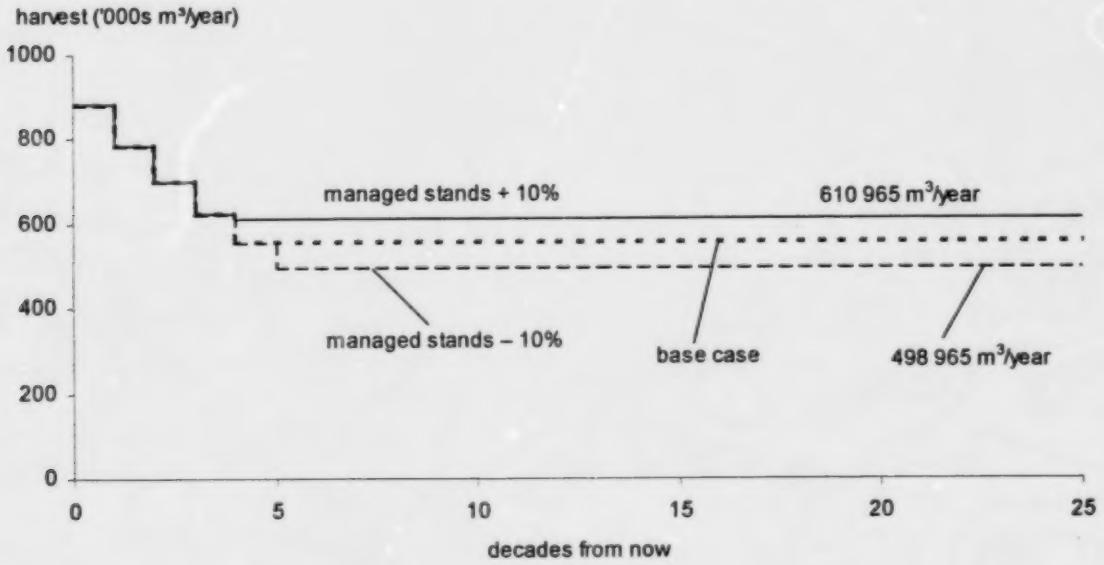

Figure 17. The effect on the harvest forecast of increasing and decreasing volume estimates for managed stands by 10%— Bulkley TSA, 2001.

Managed stand yields decreased by 10%

- New long-term harvest level of 498 965 cubic metres per year reached one decade later than in the base case.
- New long-term level is 10.1% below the base case long-term level.

When managed stand yields are increased by 10%

- Long-term harvest level increased to 610 965 cubic metres per year, 11.1% greater than the base case.

Changes to regenerated stand yields have no effect on the short-term harvest forecast for the Bulkley TSA. Regenerated stands are not eligible for harvest until they have reached their minimum harvestable ages, which range between 50 and 160 years. While some young existing managed stands will achieve their minimum harvestable ages beginning in a few decades, the timber inventory in the TSA is dominated by older existing stands. The harvest is not projected to be dominated by regenerated stands until about 100 years from now (see Figure 10).

5.5 Uncertainty about management requirements in visually sensitive areas

In the Bulkley TSA, visual quality objectives have been established only for the viewscapes around Babine Lake. Where visual quality objectives apply, limits are placed on the percentage of the area where harvesting-related disturbance may be visible. When newly established forest reaches a specified height, the disturbance is no longer visible. Uncertainties are associated with both the extent of area managed for visual quality and the allowable disturbance of visually sensitive areas.

Area managed for visual quality

The Babine viewscapes occupy 4199 hectares (1.2%) of the timber harvesting land base and the base case accounts for management practices in these areas. However, a further 58 729 hectares of the timber harvesting land base (17.3%) have been identified as visually sensitive and draft visual quality objectives (VQO) have been assigned to them. Figure 18 shows the effect on the harvest forecast if the draft VQOs were implemented in the Bulkley TSA. With the addition of the draft VQOs, the total timber harvesting land base managed for VQOs in this sensitivity analysis amounts to 62 928 hectares. However, only 36 215 hectares (58%) are managed solely for visual quality; the remaining area overlaps with other management objectives in the TSA.

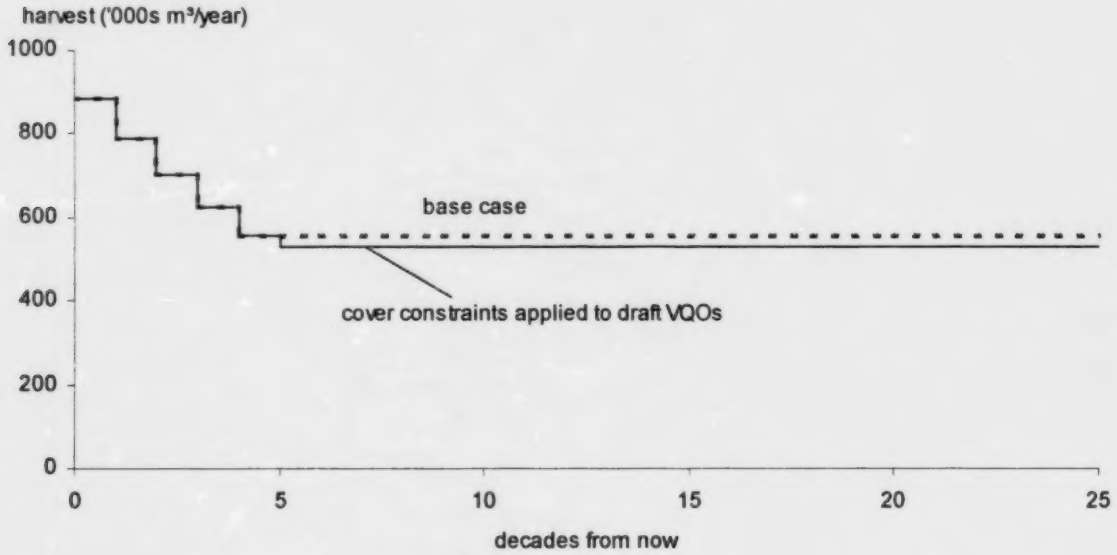

Figure 18. The effect on harvest forecast if draft VQOs are implemented— Bulkley TSA, 2001.

- Harvest forecast same as base case for first five decades.
- Long-term harvest level reduced by 4.3% to 530 965 cubic metres per year.

Percentage limits on visible disturbance

The level of harvest from visually sensitive areas is a function of the visual absorption capacity, the visual quality rating, and the current visual condition of each area. Uncertainty about forest cover and green-up objectives for visual quality may arise from inventory and classification of land into visual absorption capacity classes, from estimates of how well different disturbance limits may meet visual objectives, and from estimates of how non-harvestable forest may contribute to visual quality.

In the base case and in the sensitivity analysis above, the allowable visible disturbance applied was at the maximum of the applicable range of allowable visible disturbances (15% for partial retention* and 5% for retention*). Figure 19 shows the results of increasing the forest cover constraints for visual quality to the mid-point of the range for the Babine and the draft visual quality objectives (VQO) (10% for partial retention and 3% for retention).

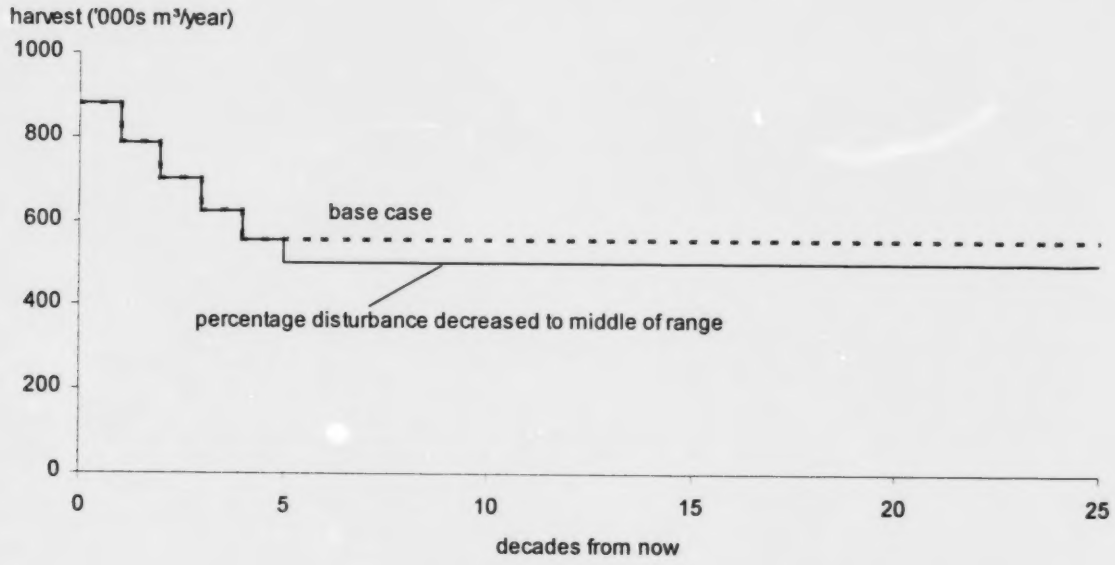

Figure 19. The effect on harvest forecast of increasing forest cover constraints for visually sensitive areas to the mid-point of the range — Bulkley TSA, 2001.

- Harvest forecast same as base case for first five decades.
- Long-term harvest level reduced by 9.7% to 500 965 cubic metres per year.

Partial retention VQO
*Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).*

Retention VQO
*Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see **Visual quality objective**).*

5.6 Uncertainty in minimum harvestable ages

Minimum harvestable ages are an estimate of the time needed for stands to reach a merchantable condition. They affect the time over which existing stands must be metered-out while regenerated stands grow to merchantability. The time at which stands will become merchantable is not known with precision because of uncertainty about the growth of regenerated stands, and an inability to foresee future conditions that will determine merchantability.

For this analysis, spruce and pine stands were considered merchantable at the age when they attained a volume of 150 cubic metres per hectare and the stems averaged a breast height diameter of 25 centimetres. Balsam and hemlock stands were not merchantable until they attained a volume of 175 cubic metres per hectare and the same average stem diameter as for spruce stands. See Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for the minimum harvestable ages applied in this analysis. Approximately 72% of the stands in the timber harvesting land base of the Bulkley TSA are currently at or above the minimum harvestable age applicable to the stand. Minimum harvestable ages are meant to approximate the timing of merchantability and are not legal or policy requirements.

Figure 20 shows how timber supply would change if stands in fact become merchantable either earlier or later than assumed in the base case.

Twenty-year decrease or increase in minimum harvestable ages

- No change from the base case harvest projections.

Minimum harvestable ages set at the culmination of mean annual increment (MAI)* age

- Same as for the base case except for a minor disruption during decades 13 to 15.

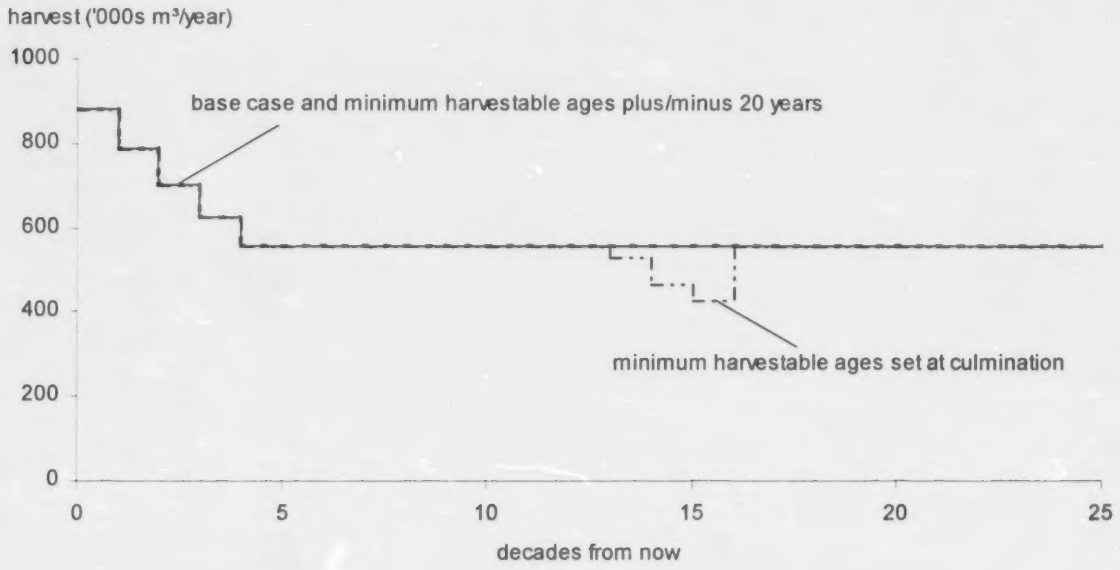

Figure 20. Harvest forecasts if minimum harvestable ages are younger or older than those used in the base case — Bulkley TSA, 2001.

Mean annual increment (MAI)
Stand volume divided by stand age. The age at which MAI assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

5.7 Uncertainty in green-up requirements

Within the Bulkley TSA base case it was assumed that no more than 33% of the timber harvesting land base within each landscape unit (LU) could be less than 3 metres in height. The 33% limit approximates a 3-pass harvest system. The age when stands attain the height condition depends on the mix of species and site productivity of the LU. The data models used in this analysis show that in the Bulkley LU, stands are greened-up on average by age 14 years, whereas in the Nilkitkwa LU stands are not greened-up until age 30 years. Some studies have shown that the time taken to achieve green-up in practice is less than the results obtained from the models used to project green-up (*Juvenile height development in interior spruce stands of British Columbia*. Nigh and Love, 2000). Both the percentage limitation and the age at which green-up is assumed to occur are sources of uncertainty.

Figure 21 shows how timber supply would change if time to achieve green-up was changed by 5 years.

Percentage allowed below green-up

- At 25% below green-up (4-pass), same as the base case harvest forecast.
- At 20% below green-up (5-pass), only small deviations from the base case harvest forecast after decade 35.

Green-up age

- Based on current site productivity information, achieving a green-up height of 3 metres requires approximately 20 years on average (varies from 14 to 31 years depending on the LU) in the Bulkley TSA.
- If the time required to achieve green-up was increased by 5 years across all LUs, there would be no change to the harvest forecast (Figure 21).
- If the time required to achieve green-up was reduced by 5 years, it would be possible to maintain the current harvest level for 2 decades before declining to the same long-term harvest level as in the base case.

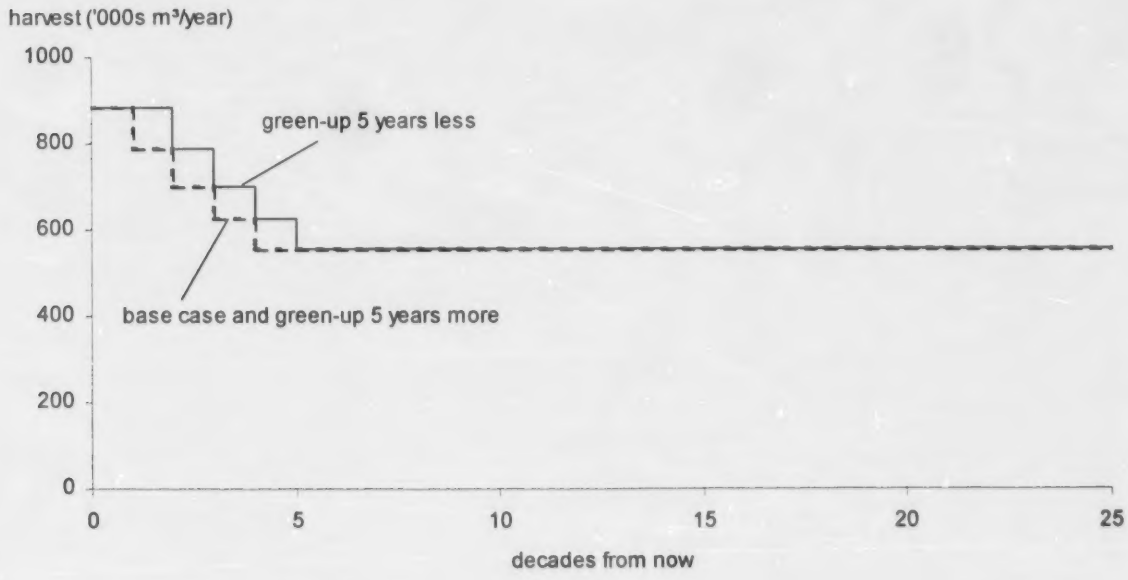

Figure 21. The effect on the harvest forecast of changing the length of time to achieve 3-metre green-up — Bulkley TSA, 2001.

5.8 Uncertainty in site productivity

The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which those stands will reach merchantable size. The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years a temporary increase or decrease in growth due to factors such as a post-harvest flush of nutrients or an unusual drought year can affect the overall productivity estimated for the stand.

Old growth site index (OGSI)

Site productivity estimates derived for older stands may be incorrect because tree heights do not represent actual productivity — for example due to top breakage — and it is very difficult to determine ages of old trees accurately. The results of recent province-wide research suggest that the estimated productivity of sites currently occupied by old-growth stands may be significantly underestimated. Two Old-Growth Site Index (OGSI) studies applicable to timber supply forecasting are:

- *Site index adjustments for old-growth stands based on paired plots* (Nussbaum 1998). Data were obtained from paired plots installed in old-growth stands and adjacent logged and regenerated stands of the same productivity. Site index* was estimated for both and comparisons were made. Results are available for Douglas-fir, lodgepole pine, and interior spruce.
- *Site index adjustments for old-growth stands based on veteran trees* (Nigh 1998). The objective of the study was to develop site index adjustments for species not covered by the paired-plot project. The data for this study came from temporary and permanent plots with a veteran and main stand component. The site indices for the two components were estimated and an adjustment equation for each species was derived using linear regression analysis. The results of the study are considered less reliable than those from the paired-plot study.

The results of these studies are of interest in the Bulkley TSA since stands older than 140 years comprise 64% of the timber harvesting land base. To test the sensitivity of the base case harvest forecast to uncertainty about site productivity estimates, an analysis was performed that incorporated adjustments to site indices.

Site indices of stands older than 140 years were adjusted using either the paired-plot or veteran-tree results, whichever was applicable. Managed stand volume estimates for those analysis units (AU)* affected by changes in estimated future productivity were recalculated based on average adjusted site productivity. Green-up and minimum harvestable ages were also recalculated. Table 4 compares the average forest inventory-based site index for each analysis unit to those defined using each of the adjustments.

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

Analysis unit
A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.

Table 4. Average analysis unit site index based on forest inventory and OGSI information — Bulkley TSA, 2001

Analysis unit	Timber harvesting land base area (hectares)	Inventory site index	Adjusted site index
Spruce — good, old	10 264	18.1	21.0
Spruce — medium, old	23 939	12.9	20.0
Spruce — poor, old	8 299	8.2	19.1
Pine — all, old	23 022	18.9	20.9
Balsam — good, old	22 444	12.8	16.1
Balsam — medium, old	90 340	9.8	14.4
Balsam — poor, old	25 618	7.7	13.2
Hemlock — good, old	3 505	13.3	18.6
Hemlock — medium, old	6 778	10.5	17.1
Hemlock — poor, old	1 774	8.0	15.8
Spruce/Pine — plan cell C7	1 006	9.0	14.0

Harvest forecast with OGSI adjustments

- Harvest forecast same as base case for first three decades (Figure 22).
- Long-term harvest level of 729 965 cubic metres per year — 31.5% above base case — can be maintained from decade 7 onward.

Old-growth site index adjustments were not included in the base case since there is little local data, and a lack of long-term monitoring data for regenerating stands to validate the adjustments. The results of the sensitivity analysis, however, do provide insight into the trends associated with possible adjustments to site productivity estimates for the Bulkley TSA.

Operational adjustment to site index study (OASIS)

The paired-plot study mentioned above provided results for only three species mainly because of a lack of sampling opportunities resulting from the province's harvesting history and regeneration strategies. In an effort to provide more reliable estimates of site productivity for a larger number of species, staff from the Ministry of Forests', Research Branch and the Prince Rupert Forest Region have developed the OASIS method which was tested in the Bulkley TSA. The OASIS method relies on the results published in *Site index estimates by site series for coniferous tree species in British Columbia* (B.C. Ministry of Forests, 1997). This report provides estimates of site productivity by species for various biogeoclimatic variant/site series combinations. For example, in the Prince Rupert Forest Region, the site index for spruce in the ESSFmc site series 06 is 15, whereas the site index for balsam in the same BEC variant/site series combination is 12 metres at a breast height age of 50 years.

In the absence of detailed site series mapping, the OASIS approach was to sample the TSA to provide an estimate of the proportion of the TSA by BEC variant/site series. The results of that sampling exercise is shown in Appendix A, Table A-25. In this sensitivity analysis, when an analysis unit is harvested the area is transferred to different regenerated analysis units depending on the composition of BEC variants/site series within the original analysis unit. Table 5 shows an example of what happens after harvesting areas in the spruce — medium analysis unit.

Table 5. Regeneration assumptions after application of OASIS site index adjustments — medium site spruce example — Bulkley TSA, 2001

Original analysis unit	Average site index	Per cent of old analysis unit transferred to new analysis unit	New analysis unit number	Site index of new analysis unit	Leading species of new analysis unit
Spruce – medium	12.9	31	702	18	Spruce
		11	802	18	Pine
		23	801	21	Pine
		21	701	21	Spruce
		9	704	12	Spruce
		5	804	12	Pine

OASIS site index adjustments were applied to all analysis units representing all ages whereas the OGSI adjustments applied only to the stands currently older than 140 years. Analysis units for sites currently classified as poor and medium showed the greatest increase in adjusted site indices. These findings are consistent with other evidence which indicate that the estimated site indices derived from the forest inventory underestimates the true site index. Both the OGSI and the OASIS methods improve the estimated site indices, but further monitoring is required to validate the methods. The site series sampling in OASIS, which provides the link between the site index estimates and the land base, is statistically rigorous. However, it is recognized that the OASIS site index data may be biased. Site index adjustments from the OASIS project were not included in the base case since further sampling is necessary to improve the reliability of the site indices-site series data in some BEC zones.

Harvest forecast with OASIS adjustments

- Harvest forecast same as base case for first three decades (Figure 22).
- Long-term harvest level of 759 965 cubic metres per year — 36.9% above base case — can be maintained from decade 7 onward.

5 Timber Supply Sensitivity Analyses

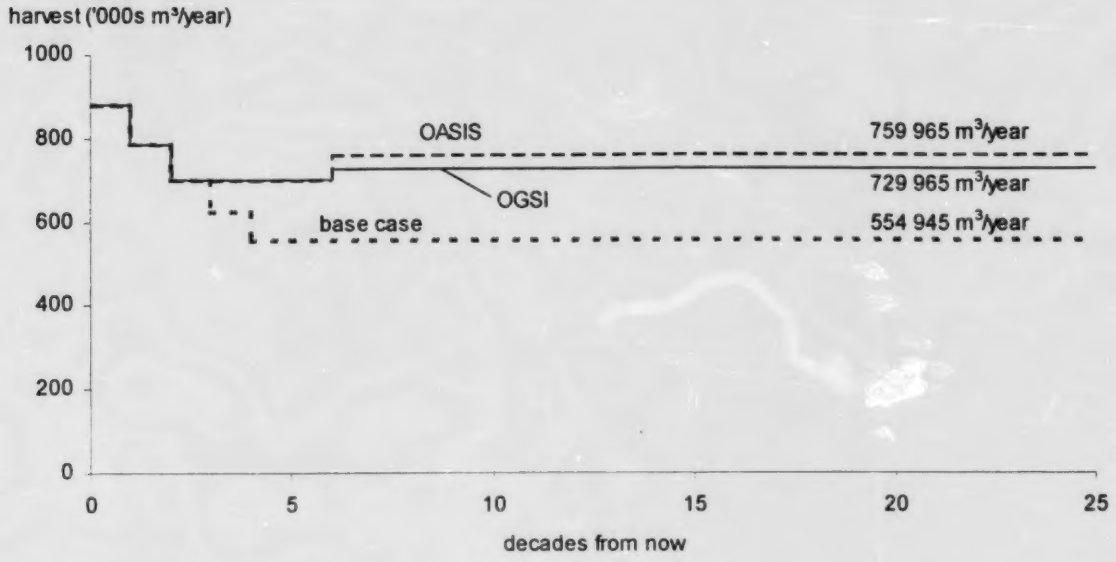

Figure 22. Harvest forecasts based on OGSI and OASIS site index adjustments — Bulkley TSA, 2001.

5.9 Alternative harvest queue rules

In the base case, the highest priority for harvest was given to stands that were the oldest relative to their minimum harvestable age. This 'relative oldest first' rule was applied only after other requirements and priorities (e.g., forest cover requirements*) were taken into account. This rule reflects the practice of favouring older stands, but not necessarily the oldest, for harvest when all other considerations have been met.

Besides the relative oldest first rule, the Forest Service Simulator (FSSIM) model can also employ absolute oldest first, absolute youngest first, and random scheduling rules. These other rules may better reflect practices in some instances, given unforeseeable operational constraints that may affect when stands are chosen for harvest. Figure 23 shows how timber supply is affected by changing the way harvesting priorities are set.

Figure 23. Alternative harvest queue (priority) rules — Bulkley TSA, 2001.

Absolute oldest first rule

- Sets the highest priority on oldest stands.
- Long-term harvest level reduced by 4.3% to 530 965 cubic metres per year.
- Growing stock slightly lower than the base case in the long term.

Random scheduling rule

- Chooses stands that are older than the minimum harvestable age in a random order for harvesting.
- Long-term harvest level reduced by 15.1% to 470 965 cubic metres per year.
- Growing stock significantly lower than the base case after decade 20.

Forest cover requirements
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see ***Cutblock adjacency*** *and* ***Green–up****).*

5.10 Uncertainty in application of seral stage* retention recommendations

The *Forest Practices Code Act of British Columbia* (FPC) describes the conservation of biodiversity as an essential component of sustainable forest use. The *FPC Landscape Unit Planning Guide* (LUPG) provides recommendation for maintaining biodiversity at both the stand- and landscape-levels. Stand-level biodiversity has been addressed in this analysis by a reduction in volume (2.3%) coming from the harvest of each stand. Therefore, uncertainty about stand-level biodiversity can be assessed through sensitivity analysis that examines the changes to existing and managed stand yields.

Management for landscape-level biodiversity was modelled in this analysis through the use of forest cover requirements applied to each combination of natural disturbance type (NDT)*, biogeoclimatic subzone, and variant within each landscape unit. In the base case, old-growth targets, as found in the *Landscape Unit Planning Guide*, were applied at the biogeoclimatic variant level within each draft landscape unit. These targets were a weighted average of the lower, medium and higher biodiversity emphasis option (BEO) targets with 45% assumed as lower, 45% as medium and 10% as higher. In areas subject to the lower BEO, an initial drawdown of the old-seral requirements to one-third of the target was allowed in the base case.

While the approach used in the base case represents current policy for managing and modelling landscape-level biodiversity, there is uncertainty about how the recommendations in the *Landscape Unit Planning Guide* will be applied once landscape units and BEOs are declared. Currently BEOs have been assigned in the Bulkley TSA so that approximately 5% of the area is considered as high emphasis, 65% medium, and 30% as low emphasis for biodiversity (current option). There is also a proposal for the area to be distributed where 10% would be in high emphasis, 45% in medium emphasis and 45% in low emphasis (draft option).

Five sensitivity analyses were performed to evaluate the potential timber supply impacts associated with uncertainty about landscape-level biodiversity management. In all the sensitivity analyses there were no changes to the base case timber supply forecasts or to the growing stock projections. The scenarios evaluated were:

1. Same as base case except that only old-seral targets must be met immediately in all landscape unit — biogeoclimatic variant combinations, i.e., no drawdown of the old-forest requirement in low biodiversity emphasis LUs.
2. Using the current option for BEOs, meet old- and mature-seral targets immediately in all landscape unit — biogeoclimatic zone variant combinations as required by the *Landscape Unit Planning Guide*.
3. Using the draft option for BEOs, meet old- and mature-seral targets immediately in all landscape unit — biogeoclimatic zone variant combinations as required by the *Landscape Unit Planning Guide*.
4. Using the current option for BEOs, meet early-, old- and mature-seral targets immediately in all landscape unit — biogeoclimatic zone variant combinations as required by the *Biodiversity Guidebook*.
5. Using the draft option for BEOs, meet early-, old- and mature-seral targets immediately in all landscape unit — biogeoclimatic zone variant combinations as required by the *Biodiversity Guidebook*.

Immediate application of old- and mature-seral forest requirements in the combinations tested had no timber supply impact because of the quantity and distribution of older forest in both the timber harvesting land base and the non-timber harvesting land base.

Seral stages
Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.

Natural disturbance type (NDT)
An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.

Aging of the forest in the non-timber harvesting land base

The base case and all the sensitivity analyses described in this report assume that the forest in the non-timber harvesting land base grows undisturbed and therefore ages throughout the planning horizon. Where there is sufficient forest in the non-timber harvesting land base, these areas will, in time, be able to provide all the old-forest requirements. As seen in Figure 6, "Current age-class composition," there is forest in the younger age classes in the non-timber harvesting land base. While it is known that there are stand-disturbing events in the non-timber harvesting land base, the rate of disturbance and the location of these events are not known well enough.

A sensitivity analysis was conducted where it was assumed that the non-timber harvesting land base will be "harvested" at a rate of 350 hectares per year. This rate was chosen so that this portion of the forest (approximately 141 000 hectares which are managed by the B.C. Forest Service) will all be disturbed over the 400-year planning horizon. When the non-timber harvesting land base was "harvested" at a rate of 350 hectares per year there was no change to the base case timber supply forecast.

5.11 Uncertainty in the growth rate of seedlings from seed orchards

Reforestation following harvesting is required by law in British Columbia and reforesting with seedlings grown from selected seed (if available) is a requirement of the *Forest Practices Code*. For the past 40 years this province was involved in a process of breeding trees with desirable traits such as faster growth, better stem and wood quality, and resistance to diseases and insect attack. Tree breeding offers potential gains in timber supply forecasting through increases in growth rate that may reduce minimum harvestable ages, increase volume at time of harvest, and ease adjacency constraints through faster green-up. Seed selected through the tree breeding program can be obtained from seed orchards located throughout the province.

In this sensitivity analysis it was assumed that all of the spruce and pine seedlings planted in the future originated from seed obtained from seed orchards. Assuming a genetic gain of 5% means that these seedlings were expected to grow 5% faster than ecologically comparable natural stand seed. The growth rate increases stated here are applicable only for a certain range in site productivity and for a specific age (80 years for spruce, and 60 years for pine). For example, a spruce stand originating from a seed orchard and planted on a medium productivity site is projected to have 5% more volume at age 80 years than a similar stand not originating from a seed orchard. However, the difference in volume yield decreases after 80 years to almost no volume difference between the two stands by age 200 years. Figure 24 shows that the long-term harvest level could increase by 3.8% if reforestation in the Bulkley TSA was accomplished using pine and spruce seeds with a genetic gain of 5%. This is lower than the gains mentioned above because, in this analysis, the actual harvest ages were seldom at age 80 years for spruce or 60 years for pine.

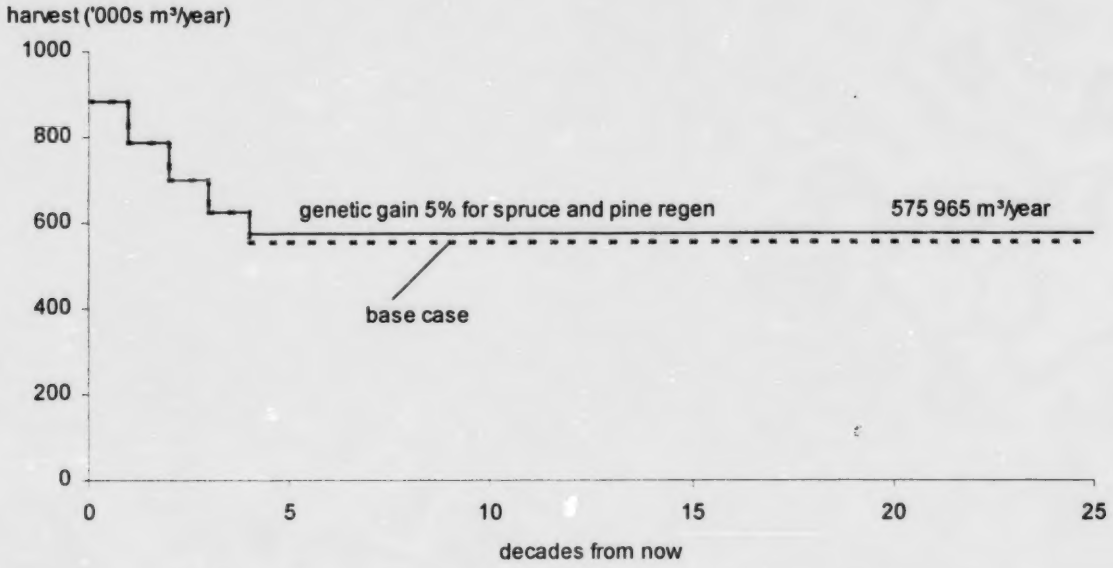

Figure 24. Harvest forecast if seeds from seed orchards were used for reforestation — Bulkley TSA, 2001.

5.12 Uncertainty in the utilization standards for timber

The utilization level defines the maximum stump height, minimum top diameter and minimum diameter at breast height (dbh) by species and is used to calculate the volume of individual trees. In Section 5.6, "Uncertainty in minimum harvestable ages" one of the criteria used to determine whether a stand was merchantable was that the average diameter at breast height of all stems had to be at least 25 cemtimetres. Thus, it is quite likely that a stand may have many merchantable trees but the stand itself is not harvestable. In the base case marginal sawlog and pulpwood quality trees were considered merchantable if those trees had a dbh greater than or equal to 12.5 centimetres. All other trees were merchantable if their dbh were greater than or equal to 15 centimetres. Provincial utilization standards specify a diameter at breast height of 12.5 centimetres for pine and 17.5 centimetres for all other species. Thus, for a spruce–leading stand, using the provincial utilization standards, only trees with a dbh greater than or equal to 17.5 cm would contribute to the merchantable volume of the stand, whereas in the base case all trees with a dbh greater than or equal to 15 cm would contribute to the merchantable volume of the stand. Figure 25 shows that if provincial utilization standards were used to project merchantable volume from existing and regenerated stands in the Bulkley TSA, the long-term timber supply would decrease by 4.3% to 530 965 cubic metres per year.

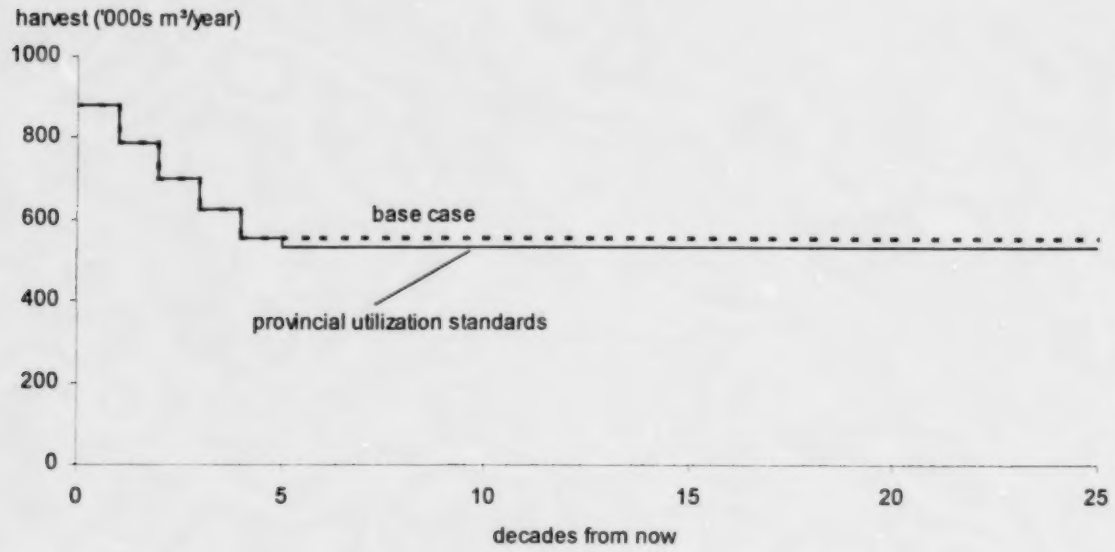

Figure 25. Harvest forecast if provincial utilization standards were used to estimate merchantable volume — Bulkley TSA, 2001.

6 Summary and Conclusions of the Timber Supply Analysis

The results of this timber supply analysis suggest that, given data and management assumptions that reflect current information and practices, the current allowable annual cut in the Bulkley TSA of 882 000 cubic metres per year can be maintained for ten years. After ten years, the projected harvest level declines by 10% per decade, reaching a steady level of 554 945 cubic metres per year in 50 years. A series of sensitivity analysis showed that data and management uncertainties affect timber supply projections to varying degrees, some with positive impacts and others with negative impacts.

Short-term timber supply is sensitive to changes that influence the amount of timber available from existing unmanaged stands, because the harvest forecast relies on harvests from these stands for the next 100 years. Estimates of timber volumes in existing stands has the largest potential to affect the base case projection of short-term harvest levels (next 20 years). An audit conducted in 2000 showed that the inventory estimate of volume in all mature stands (over 60 years old) was approximately 9% above the estimate derived from ground samples. When samples from the operable portion only of the TSA (approximately the timber harvesting land) were considered, volumes estimated using inventory information were 12% higher than estimates based on ground measurements. If existing stand volumes are indeed 12% lower than the inventory estimates and the current harvest level is maintained, this analysis shows that timber supply will decline to 11.2% below the base case level during decades 6 to 11. After decade 11, when the harvest is mainly from managed stands, timber supply returns to the same level as in the base case.

The length of time taken to achieve green-up conditions also affected short-term timber supply. Sensitivity analysis suggested that if green-up heights were achieved five years earlier than assumed in the base case, the current harvest level could be maintained for two decades before declining to the same long-term harvest level as obtained in the base case.

Medium-term (21 to 100 years from now) timber supply is affected by many of the factors tested through sensitivity analysis. Because the long-term harvest level is about 37% lower than the starting harvest level, changes in factors that alter either the total amount of existing volume, or the ability to access existing volume during the first 100 years will affect medium-term timber supply. The medium term is affected by changes in: the size of the timber harvesting land base; volumes from existing stands; volumes from managed stands; the rules governing which stands are selected for harvesting; old-growth site index estimates, forest cover requirements for management of visual quality; and the standards used to define merchantable trees.

Changes in the amount of the land base that is available for harvesting have direct effects on medium-and long-term timber supply. When the timber harvesting land base was increased by 9.2%, through the addition of areas suitable for cable logging, medium- and long-term timber supply increased by 5.7%. When the timber harvesting land base was decreased by 11.5%, through the removal of low site areas, medium- and long-term timber supply decreased by 4.3%.

Uncertainty in managed stand volumes had proportional changes to medium- and long-term timber supply. If managed stand volumes were 10% higher than estimated then medium- and long-term timber supply were 10% higher. If managed stand volumes were 10% lower than estimated then medium- and long-term timber supply were 10% lower than the base case. Managed stand volumes were projected to increase if genetically improved spruce and pine seedlings were used in future plantations, with a projected 3.8% increase in the long-term harvest level. If provincial utilization standards were used to determine tree merchantability, managed stand volumes were lower than projected in the base case, with a projected 4.3% increase in the long-term harvest level.

Another factor with potential impacts on medium- and long-term timber availability is the rule used to set harvest priority. The analysis showed significant impacts when merchantable stands (older than the minimum harvestable age) were chosen at random for harvesting, rather than the relative oldest first rule used in the base case. It is unlikely that the relative oldest stands in the TSA are always given the highest harvest priority. Nevertheless, the analysis showed the potential impacts on timber supply resulting from changes to harvest priority.

6 Summary and Conclusions of the Timber Supply Analysis

If site productivity is underestimated for existing old-growth stands as suggested by recent research, yields in managed stands could be significantly higher than in the base case harvest forecast which would boost long-term supply directly. Medium-term supply would also be increased because the higher volume managed stands would be available for harvest sooner than assumed in the base case. In the Bulkley TSA, stands older than 140 years comprise 64% of the timber harvesting land base and the OGSI adjustment resulted in a 31.5% increase in medium- and long-term timber supply. The OASIS approach to site productivity estimates, which relies on the biogeoclimatic ecosystem classification of the land base, indicated that medium- and long-term timber supply could be 36.9% higher than the base case projections.

In the base case, management objectives for visual quality applied only to the Babine Lake area (1.2% of the timber harvesting land base). However, there are draft visual quality objectives for a further 17.3% of the timber harvesting land base. Medium- and long-term timber supply would be reduced by approximately 4.3% if these draft areas were declared as VQOs in the Bulkley TSA. The assumption in the base case and in the aforementioned sensitivity analysis was that the disturbance in the VQO areas would be at the maximum of the allowable range. If the allowable disturbance was in the middle of the range, medium- and long-term timber supply were expected to be 9.7% below the base case.

Long-term (over 100 years from now) timber supply is affected by uncertainties in all the above factors with the exception of changes to existing stand volumes.

In conclusion, this analysis indicates that based on current inventory, growth and yield, and forest management information, timber harvests in the Bulkley TSA can be maintained at the current level for 10 years. The existing partition of 367 000 cubic metres per year for marginal sawlog and pulpwood can be maintained for 20 years. The analysis indicates that several factors related to the current forest inventory and management regime could affect timber supply. However, except for the likelihood that existing stand volumes may be overestimated, and site indices for old-growth stands may be underestimated, there is no conclusive evidence to suggest that significant inaccuracies exist in the information used in this analysis.

7 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the timber supply review. This socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Bulkley TSA with the level of activity that could be expected given the timber supply projections over the long term.

The socio-economic analysis examines the short- to long-term harvest levels as projected in the base case harvest forecast. The base case is intended to reflect current forest management practices; consequently, the socio-economic analysis does not evaluate alternative management scenarios.

The socio-economic analysis includes:

- a profile of the current socio-economic setting;
- a description of the Bulkley TSA forest industry; and
- an analysis of the socio-economic implications of the base case harvest forecast.

7.1 Current socio-economic setting

7.1.1 Overview

The socio-economic analysis focuses on the timber supply from the Bulkley TSA, located in the northwest of B.C.'s interior. The Bulkley timber supply area comprises approximately 762 540 hectares. However, the TSA is part of the larger Bulkley/Cassiar Forest District. The forest district includes the Cassiar TSA, numerous parks and woodlots. Since communities are located throughout and employment is not easily separated, this section profiles the Bulkley area.

7.1.2 Population and demographic trends

According to the 1996 Census, since 1991 the population of the Bulkley area increased 14% to 13,107. In comparison, the population of the province also increased by 14% over the same period. The population of the Bulkley TSA is concentrated in Smithers (5,624). Other smaller communities include Telkwa (1,194), Moricetown (700) and Fort Babine (130). By 2001, the population of the district is expected to grow by another 7% to approximately 14,042.[1]

7.1.3 Economic profile

The average unemployment rate in the Bulkley TSA in 1996, was about 10%, slightly higher than the provincial average of 9.6%. Activity in Smithers dominates the economy of the TSA, and is well diversified although resource-oriented. The unemployment rate in Smithers was 7.1% in 1996. The predominant industries in the region are forestry, mining, agriculture and tourism. Smithers is serviced by commercial air and bus service as well as being on the CN Rail Line. Highway 16, a well maintained, major highway, runs west to Prince Rupert (350 kilometres) and east to Prince George (370 kilometres).

The countryside supports a variety of outdoor activities, including hiking, horseback riding, fishing, mountain biking, white-water boating, cross-country and downhill skiing. Smithers is a popular base for self-guided and fully guided activities. Sports fishing in the area's major rivers and tributaries is world class and enjoys a long season. Area lodges and resorts cater to a variety of tastes offering packaged and custom itineraries for everything from fishing, wildlife viewing and photo safaris to canoeing and float trips.

(1) B.C. Stats. Population Section.

7 Socio-Economic Analysis

By early December, the area is cloaked in winter with some of B.C.'s finest powder skiing on Hudson Bay Mountain. There are miles of runs for skiers of all levels and extensive cross-country ski trails. Snowmobilers enjoy the vast expanses of the winter backcountry.

Smithers is the location of four major timber processing facilities; Skeena Cellulose Inc. lumber operations, West Fraser Mills Ltd. chip and lumber plant, Alpine Cedar Products shake and shingle mill, and Northern Engineering Wood Products particleboard facility. During 1999 direct forestry-related employment at Bulkley TSA mills amounted to approximately 450 positions. Figure 26 illustrates the shares of total employment by industry sector for the Bulkley/Cassiar Forest District. Although it suggests limited dependence on forestry, the "other" sector (transportation and some manufacturing) includes significant amounts of direct and indirect forestry related activity, as does the "public sector."

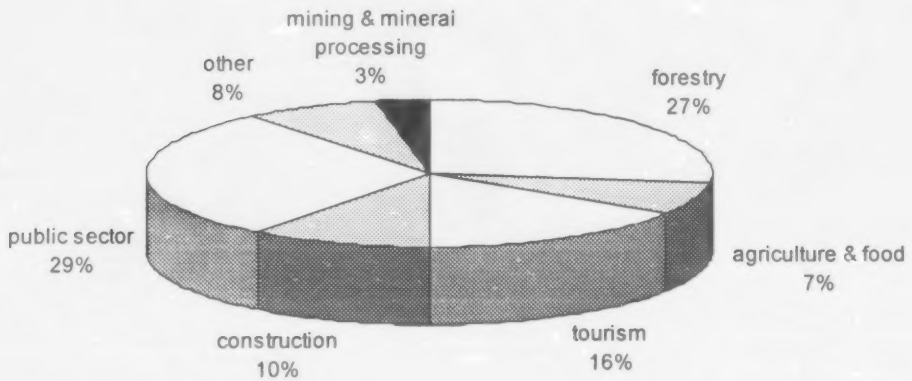

Figure 26. Total employment by basic sector — Bulkley TSA, 1996.*

Notes: The figures are for the Bulkley area. Percentages reflect direct, indirect, and induced employment supported by the basic sector. "Other" (basic sectors) consist of some manufacturing, and transportation.

Source: The 1996 Forest District Tables. B.C. Ministry of Finance and Corporate Relations.

Basic sector
Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy. Non-basic sectors, such as retail outlets, are supported by basic sectors.

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The forest sector supports numerous other jobs in the region through companies and employees purchasing goods and services from local businesses. This spending is another indicator of the role forestry has in the economy. Each 100 direct forestry jobs in the Bulkley TSA are estimated to support a further 35 to 64 indirect and induced jobs*,[2] depending on the type of forestry activity (logging, pulp and paper, or wood manufacturing) and the associated level of income. (The weighted average for the forest sector is 47). In comparison, each 100 mining and mineral processing jobs support approximately 55 positions, the public sector supports 18 additional positions per 100, while each 100 tourism jobs support approximately six positions.

(2) The 1996 Forest District Tables, April 1999, Ministry of Finance and Corporate Relations.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

A breakdown of income dependencies (including direct, indirect and induced impacts) further confirms forestry's importance to the economy of the Bulkley TSA. Twenty-six per cent of all basic, after tax income is forestry dependent,[3] accounting for about 26% of all local employment.[4]

7.2 Bulkley TSA forest industry

7.2.1 Current allowable annual cut

In 1995, the chief forester set the current allowable annual cut (AAC) for the Bulkley TSA at 895 000 cubic metres. The AAC includes a partition of 367 000 cubic metres for the harvest of marginally economic forest types.

The AAC is apportioned by the Minister of Forests into a number of licence types as outlined in Table 6. Three ventures have forest licences in the TSA (West Fraser Mills, Skeena Cellulose, and the Moricetown Band Council) accounting for roughly 50% of the total AAC. The remainder is apportioned among several other forms of tenure including timber sale licences and the Small Business Forest Enterprise Program (SBFEP).

Table 6. Bulkley TSA allowable annual cut apportionment, by licence type

Licence types	AAC (m^3/year)	Per cent of total (%)
Forest licences — replaceable	434 444	48.5
Forest licences — non-replaceable	185 000	20.7
Small Business Forest Enterprise Program (SBFEP)	238 976	26.7
Timber sale licences — replaceable	17 080	1.9
Woodlots licences	13 000	1.5
Forest Service Reserve	6 500	0.7
Total	895 000	100.0

Source: Ministry of Forests – 2000.

7.2.2 Bulkley TSA harvest history

The actual annual harvest level is an important indicator of forestry activity in the timber supply area. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year indicates the economic activity supported by the timber supply area. If actual annual harvest levels are consistently less than the AAC, then the economic activity is below its full potential. This gap between actual and allowable harvest activity will influence the potential short-term impacts of changes to the AAC.

From 1998 to 2000, an average of 824 000 cubic metres were harvested annually from the Bulkley TSA. Additional (non-TSA) sources of timber include private lands and Indian reserves, which amounted to approximately 8000 cubic metres per year over the same period. The Bulkley TSA makes up about 12% of the total harvest in the Prince Rupert Forest Region (7.4 million cubic metres) while the region, in turn, accounts for about 10% of the total provincial harvest (71 million cubic metres).

(3) Ibid.

(4) Ibid.

7 Socio-Economic Analysis

Table 7 summarizes the volume of timber harvested in the Bulkley TSA from 1998 to 2000. It indicates a fairly consistent level over the period, despite changes in export market conditions and provisions for cut control[5] that allow licensees to vary their harvest levels based on operating and market conditions.

Table 7. Bulkley TSA volumes billed, by licence type, 1998-2000

Licence type	Cubic metres per year (m^3/year)			
	1998	1999	2000	Average 1998-2000
Forest Licences	507 997	555 866	580 153	548 005
Small Business Forest Enterprise Program (SBFEP)	233 246	232 287	160 040	208 524
Other[a]	75 992	78 270	48 156	67 473
Total	817 235	866 423	788 349	824 002

Source: Ministry of Forests.

(a) Other consists of cutting permits such as rights-of-way, road permits, woodlot licences and other smaller permits.

7.2.3 Bulkley TSA major licensees

West Fraser Mills Ltd.

West Fraser Mills Ltd. (West Fraser) has a replaceable forest licence (311 562 cubic metres per year) and a non-replaceable licence (185 000 cubic metres per year) to harvest a total of 496 562 cubic metres per year in the Bulkley TSA. In addition, West Fraser holds 14 other tenures throughout the province, amounting to 3.7 million cubic metres per year of allowable annual harvest, making it the fourth largest tenure holder in B.C. Table 8 outlines West Fraser's recent harvest activity in the Bulkley TSA and its 1998 employment levels from TSA operations.

West Fraser began operations in 1955 and is now an integrated forest products company producing dimension lumber and related solid wood products, fibreboard, pulp, linerboard, kraft paper and newsprint. The company also owns and operates a chain of retail home improvement stores in Canada.

(5) A licensee's harvest may differ from the AAC by up to 50% on an annual basis, although the average harvest must be within 10% of the AAC over each five-year period.

7 Socio-Economic Analysis

West Fraser operates a large lumber and chipping complex in the Bulkley TSA, located in Smithers. The chipper can process up to 175 000 cubic metres per year and the dimension mill about 600 000 cubic metres. Wood chips from both lines are trucked to the Skeena Cellulose pulp and paper complex (also in Prince Rupert), and to West Fraser's pulp and paper mill in Kitimat, where they support additional employment. In 1999, West Fraser's processing operations at Smithers supported approximately 200 direct processing jobs.

West Fraser has interests in nine sawmills in B.C. producing dimension lumber and by-product wood chips. Lumber produced by the sawmills is sold by West Fraser's lumber sales department to retail and wholesale customers and lumber brokers. In 1998, 72% of lumber sales were to customers in the United States and 25% to Canadian customers, who resold a significant portion into the United States. Asian and other customers accounted for the remaining 3% of sales. Most of the sales to North American customers are shipped by rail directly from the sawmills. The remainder are shipped by truck or by water through West Fraser's deep-sea terminal at Kitimat.

Table 8. West Fraser harvest and direct employment statistics

Allowable annual cut (AAC)		496 562 cubic metres
1998 harvest		426 997 cubic metres
1998 – 2000 average harvest		444 226 cubic metres
Direct employment (person-years)		
Harvesting, silviculture and administration	99	
Processing	166	

Note: The employment figures relate to the volumes harvested from the Bulkley TSA land base only.

Skeena Cellulose Inc.

Skeena Cellulose Inc. (Skeena) has a replaceable forest licence to harvest 122 882 cubic metres per year in the Bulkley TSA. Skeena is British Columbia's eighth largest licence holder at 2.3 million cubic metres per year and employs about 1,200 people in the Prince Rupert pulp mill and various other sawmills in northwestern B.C. Table 9 summarizes the harvest activity and employment associated with Skeena's 1998 operations in the Bulkley TSA.

Skeena operates a sawmill in Smithers, with an annual capacity of approximately 200 000 cubic metres of timber. The plant employs approximately 175 people. Skeena also operates four other timber processing facilities in the Prince Rupert Forest Region. In 1999, Skeena's Prince Rupert facilities processed slightly over two million cubic metres of timber.

Table 9. Skeena Cellulose harvest and direct employment statistics

Allowable annual cut (AAC)	122 882 cubic metres
1998 harvest	53 933 cubic metres
1998 – 2000 average harvest	81 439 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	15
Processing	70

Note: The employment figures relate to the volumes harvested from the Bulkley TSA land base only.

Other licensees

Other licensees in the Bulkley TSA are mainly comprised of Small Business Forest Enterprise Program (SBFEP) participants with an AAC apportionment of 238 976 cubic metres. From 1998 – 2000, SBFEP harvests averaged 208 524 cubic metres annually, which could support about 250 direct harvesting, silviculture and processing person-years.

Other processing facilities

In addition to the mills discussed above there are a number of smaller processing facilities. Since 1980, Northern Engineering Wood Products Inc. has operated a particleboard mill in Smithers, which employs about 55 people. Seaton Timber Inc. is a family owned and operated vertically-integrated forest products company, located in Smithers. Its operations, which employ 40 people, include logging, trucking, sawmilling and value-added lumber processing. Kyahwood Forest Products Ltd. is a joint venture by Northwood Inc. (49%) and the Wet'suwet'en people (51%) located in Moricetown. Kyahwood is a value-added operation that produces finger-jointed lumber in varying lengths and employs about 35 people. Finally, Alpine Cedar Products Ltd. operates a shake and shingle mill, also in Smithers, which employs about 20 people.

7.2.4 Forest sector employment summary

In this section, the preceding harvesting and employment information is considered in the development of employment coefficients used to project future employment levels. For this purpose, the forest sector has been divided into the following three sub-sectors:

- harvesting and other woodlands-related employment such as log salvage and log scaling, and planning;
- silviculture activity including all planting and other basic and intensive operations; and
- primary timber processing employment.

Harvesting and silviculture employment

The harvesting sub-sector of the forest industry includes both company and contract loggers and is the most closely tied to the AAC; consequently, harvest level changes will affect this sub-sector first, close to the same

The silviculture sub-sector is less linked to the current level of harvest, since silviculture activities occur at least three to six years after harvesting. Silviculture activity is divided into basic and enhanced work. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collecting and some spacing. Enhanced, or intensive silviculture includes spacing, fertilizing, and pruning*. In the Bulkley TSA, licensees are responsible for basic silviculture on areas harvested under forest licences. The provincial government is responsible for the remaining basic and all enhanced silviculture on Crown land, which is normally completed by silvicultural contractors.

Pruning
The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

Primary timber processing employment

Processing facilities in the TSA rely on the Bulkley TSA and other TSAs, TFLs, woodlots, and private lands in the area for their timber supply. Timber from the Bulkley TSA also supports processors located throughout the region and province.

Forest Service employment

The Bulkley TSA is administered by the Bulkley/Cassiar Forest District office in Smithers. Currently, 50 people work in the forest district office. Forest Service staff administer and enforce statutory requirements associated with the *Forest Act*, the *Range Act* and the *Forest Practices Code*; and plan for the SBFEP in the Bulkley TSA, and woodlots within the Bulkley/Cassiar Forest District. Forest Service employment is not included in the forestry sector discussion regarding impacts; nonetheless these jobs are included in the public sector employment.

Bulkley TSA forestry employment and employment coefficient summary

Table 10 summarizes employment supported by the 1998–2000 average harvest in the Bulkley TSA, and the corresponding employment coefficients. The employment and coefficients are separated into two groups:TSA employment and employment coefficients, which comprise residents of the Bulkley TSA who are employed within the Bulkley TSA; and

- Provincial employment and employment coefficients, which comprise all forest sector employment in the province that relies on the Bulkley Timber supply; including both residents of the Bulkley TSA and those who live elsewhere.

Calculations have been made for both groups to identify the importance of the forest sector within the Bulkley TSA and to highlight the contribution that the Bulkley TSA's forest sector makes to the provincial economy.

The average annual harvest from the timber supply area, from 1998–2000, was 824 000 cubic metres, 8% less than the current AAC. If the full AAC of 895 000 cubic metres was harvested, it could potentially support a higher level of employment.

Table 10. Bulkley TSA employment and employment coefficients

Activity	TSA person-years	TSA coefficients	Provincial person-years	Provincial coefficients
Harvesting and silviculture	282	0.34	314	0.38
Processing	285	0.35	461	0.56
Total direct	567	0.69	775	0.94
Indirect and induced	265	0.32	904	1.10
Total employment	833	1.01	1,679	2.04

Note: Employment estimates are person-years based on average 1998-2000 employment levels and the average 1998-2000 harvest of 824 000 cubic metres. Person-years do not indicate individual jobs. Wood products transport, and road building and maintenance are included in indirect estimates. For further discussion see the economic impact analysis methodology appendix.

More detailed information regarding employment coefficients is presented in Appendix B, "Socio-Economic Analysis Background Information."

7.2.5 Bulkley TSA employment income

From 1997–1999 the average annual income for direct forest sector employees was approximately $48,600 (depending on the type of forestry activity); and $30,300 for indirect and induced employment (in 1998 dollars). Based on these averages, current harvesting, silviculture, and processing of timber from the Bulkley TSA generates an estimated $37.7 million in direct wages and salaries and $27.4 million in indirect and induced wages and salaries, annually throughout the province (see Table 11).

Table 11. Average annual direct and indirect/induced incomes and total employment income, 1998-2000

	Average annual income (1998 dollar value)	Total annual income ($ millions)	Total income ($ per '000s m³)
Direct	48,600	37.7	45,750
Indirect / induced	30,300	27.4	33,250
Total income		65.1	79,000

Source: Statistics Canada, Survey of Employment Payrolls and Hours.

7.2.6 Provincial government revenues

Provincial government revenues from the forestry industry include stumpage, royalties and rent payments, other taxes such as logging, corporate capital, sales, property and electricity taxes, and income taxes from direct, indirect and induced employees.

From 1998 to 2000, average stumpage and rent payments for Crown timber in the Bulkley TSA were approximately $14.8 million per year. Forest and corporate taxes and revenues generated $5.8 million, while employment supported by the Bulkley timber harvest accounted for $5.9 million in provincial income taxes (see Table 12).

Table 12. Average annual provincial government revenues, 1998-2000

	Average annual revenue 1998-2000 ($1999 millions)	Revenue ($ per '000s m³)
Stumpage, rents and royalties	14,800	18,000
Industry taxes	5,760	7,000
Provincial income tax	5,975	7,250
Total government revenues	26,525	32,250

7.3 Socio-economic implications of the base case harvest forecast

The base case harvest forecast suggests that a harvest level of 882 000 cubic metres per year (the current AAC adjusted to account for issued woodlots) could be maintained for one decade before declining 10% per decade to the steady long-term harvest level of 554 945 cubic metres per year. The socio-economic analysis focuses on the base case harvest level changes in this short- to medium-term period, and considers:

- the short- and long-term implications of alternative harvest levels for both the Bulkley TSA and the province;
- possible impacts on the communities within the TSA;
- timber requirements of processing facilities within the Bulkley TSA; and
- regional timber supply implications.

The socio-economic analysis considers the average levels of forestry activity that the base case harvest forecast could support, assuming that employment changes by the same percentage as the harvest level, and that the proportion of harvesting, processing, and silviculture employment remains the same. Since the analysis also assumes that the types and proportions of products manufactured remain constant, it does not attempt to predict how timber flows, technology or product lines may change in response. The analysis provides an indication of the magnitude of impacts to expect within a constantly changing socio-economic environment.

Employment and income impacts are divided into direct, indirect and induced components; the sum of all the components is the total impact. Direct impacts reflect harvesting, silviculture, and processing activity. Indirect impacts are the result of direct businesses purchasing goods and services, and induced impacts are the result of direct and indirect employees spending their incomes on consumer goods and services.

Table 13 estimates the range of impacts the base case harvest forecast may have on employment and income. Ranges are utilized to reflect the availability of employment insurance and social assistance payments, and their mitigating effects in the shorter term. The lower end of the range reflects induced impacts which are diminished in the short term, because employment insurance and social assistance provide income support to displaced workers. The upper end of the range represents long-term impacts when displaced workers leave the area, and local spending patterns are more fundamentally affected. In reality, a combination of these two scenarios — some workers accessing social assistance payments, some finding alternate employment and some leaving the area completely — is more likely to occur.

7.3.1 Short- and long-term implications of alternative harvest levels

Bulkley TSA employment and income impacts

For accounting purposes, TSA employment and income includes only that of workers who are supported by the TSA harvest and who reside within the TSA. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as is employment supported by Bulkley TSA timber processed at mills outside the TSA. Table 13 indicates the employment and income that could be supported within the Bulkley TSA by the base case harvest forecast. If fully harvested and processed, the base case harvest level of 882 000 cubic metres could support approximately 607 person-years of direct employment and another 284 indirect and induced person-years of employment within the timber supply area. Approximately $29.5 million (1998 dollar value) total after-tax annual income would be supported, within the TSA, by the Bulkley timber supply.

In the sixth decade, the reduced harvest level of 554 945 cubic metres per year could support approximately 382 person-years of direct employment and 179 person-years of indirect and induced employment; a reduction of about 37% (approximately 331 person-years). Total after-tax employment income would decline from initial levels by approximately $10.9 million to $18.6 million per year.Approximately 73% of all direct employees reside within the Bulkley TSA. Changes to the Bulkley harvest levels should be expected to have the greatest effect on residents of the Smithers area; the largest centre in the TSA. However, Bulkley TSA processing is also dependent on the regional timber supply situation.

Provincial employment and income impacts

Provincial employment and income impacts include all forest sector employment supported by the timber harvested from the Bulkley TSA. If the base case harvest level of 882 000 cubic metres is fully harvested and processed, the Bulkley TSA could support about 828 person-years of direct forestry employment and a further 967 person-years of indirect and induced employment across the province and contribute $55.6 million (1998 dollar value) in total after-tax annual income. After 50 years, the base case harvest level of 554 945 cubic metres per year would lower total employment potential by about 665 person-years; about 45% of which would be direct forestry jobs. Net employment income would drop about 37% to $35.0 million.

Provincial government revenue impacts

Based on current tax and stumpage rates, the base case harvest level of 882 000 cubic metres per year has the potential to provide approximately $28.4 million annually to the provincial government (1998 dollar value), $1.9 million more than the actual 1998-2000 average harvest level provided. After 50 years, if the harvest level is reduced to 554 945 cubic metres, annual provincial government revenues would be about $17.9 million (assuming current taxation and stumpage rates do not change).

7 Socio-Economic Analysis

Table 13. Socio-economic impacts of the base case harvest forecast — Bulkley TSA, 2001

	Current	Base case harvest forecast	
		Initial harvest level (0-10 years)	Steady long-term level (Year 50+)
Timber supply (m³/year)			
AAC	895 000	882 000	554 945
Actual harvest level (average 1998-2000)	824 000		
Cumulative change			– 256 515
Bulkley TSA			
Employment		(person-years)	
Direct	567	607	382
Indirect / induced	265	284	179
Total	832	891	561
Cumulative change in total person-years		(54) – 115	(343) – (237)
Net employment income		($1998 million)	
Direct	20.6	22.1	13.9
Indirect / induced	7.0	7.4	4.7
Total	27.6	29.5	18.6
Cumulative change in total income		(1.0) – (1.9)	(10.9 – (9.0)
Province (includes Bulkley TSA)			
Employment		(person-years)	
Direct	774	828	521
Indirect / induced	904	967	609
Total	1,678	1,796	1,130
Cumulative change in total person-years		(88) – 118	(677) – (548)
Net employment income		($1998 million)	
Direct	28.3	30.3	19.0
Indirect / induced	23.7	25.4	16.0
Total	52.0	55.7	35.0
Cumulative change in total income		(1.7) – 3.7	(20.4) – (17.0)
Provincial government revenues		($1998 millions)	
Provincial income tax	6.0	6.4	4.0
Stumpage and rent	14.8	15.9	10.0
Other B.C. revenues	5.8	6.2	3.9
Total B.C. revenues	26.5	28.4	17.9
Cumulative change in total revenue		1.0 – 1.9	(9.2) – (8.7)

Notes: Provincial employment includes both Bulkley TSA employment and employment supported outside the TSA by Bulkley TSA harvested timber.

Income figures in Table 13 are net of taxes while those in Table 11 are gross income.

The ranges for employment and income changes take into consideration employment insurance and other social assistance programs. The range's upper limit is based on the assumption that all those who are unemployed will leave the TSA. The lower limit is based on the assumption that employment insurance and other social assistance payments will reduce the induced impacts of a lower harvest level.

7.3.2 Community-level impacts

The impacts of short- and long-term changes in timber supply occur within a growing region. The more diversified the region the less effect changes in any one sector will have on the regional economy. For less diversified and more remote communities, any reduction to timber supply may lead to population declines and alter the structure of the local economy.

The Bulkley timber harvest provides almost 30% of the total basic employment in the TSA. Given that, changes to the timber supply might be expected to have a fairly significant impact on the overall economic trends of the region. However, considering that the year 2000 actual harvest levels were 12% below the AAC, and that the average 1998–2000 harvest levels were 8% below the AAC, the impacts of short-term declines will be minimal. It is anticipated, however, that the harvesting and primary processing components of the forestry industry will decline in the TSA over the longer term.

7.3.3 Nature, production capabilities, and timber requirements of processing facilities

Assuming that a reduction in the Bulkley TSA timber supply is spread evenly among tenures, an initial reduction will have little to no effect on local processing activity. In the longer-term, the timber supply will decline to 554 945 cubic metres (33% less than its 1998-2000 average level) assuming a continuation of current forestry management practices. This translates into a 37% reduction from the initial base case harvest forecast, which will likely be sufficient to lead to more significant impacts (e.g., shift reductions and/or closures), depending on conditions at individual mills. It is pertinent that the long-term harvest level will only be 30% lower than the year 2000 actual harvest level.

7.3.4 Regional timber supply implications

Approximately 80% of the total milling requirements — 1.0 million cubic metres per year — of the processing facilities in the Bulkley TSA is harvested from the timber supply area.

The future of the regional timber supply is also important to primary processing facilities in the Bulkley TSA. In the Prince Rupert Forest Region, the previous timber supply review led to a reduction in the coniferous AAC of 6.8%, or about 600 000 cubic metres. In two to three decades, the annual timber supply from the Prince Rupert Forest Region may fall by another 5%, or 400 000 cubic metres, assuming that current forest management remains the same.

Mill level impacts then will not occur solely as a result of changes in the volume of timber harvested from the Bulkley TSA; they also result from harvest changes that occur across the region. It is not possible to predict, however, which mills and regions will be most affected, or if new "value added" operations will offset or exacerbate some of these changes.

7.4 Summary

The forestry sector is an important source of employment and income for the Bulkley TSA. Approximately 80% of the TSA's processing facilities' capacity requirements of 1.0 million cubic metres per year (chips and lumber) comes from the Bulkley TSA. The current AAC for the Bulkley TSA is 895 000 cubic metres. If the base case harvest level of 882 000 (does not include 13 000 cubic metres for issued woodlot licences) is fully harvested and processed, it can support approximately 828 person-years of direct employment across the province and a further 967 indirect and induced jobs.

7 Socio-Economic Analysis

The base case harvest forecast for the Bulkley TSA indicates that the timber supply could be maintained (after accounting for woodlot licences) at initial harvest levels for the next decade. In the following decades, the harvest level is projected to decline to 554 945 cubic metres, which could reduce direct employment by approximately 253 person-years, and indirect and induced employment by a further 295 person-years from current (1998-2000 average) levels. At that time, the Bulkley TSA could support approximately 521 person-years of direct employment and 609 person-years of indirect and induced employment. Regional effects could be in sharp contrast to individual community impacts. Smaller communities are the most vulnerable to forest sector changes. Individuals who lose their jobs in any sector often have difficulty financially and emotionally, and the specialized skills acquired in forestry jobs are often not easily transferable to other employment.

8 References

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9 Glossary

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Analysis unit
A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.

Base case harvest forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

Basic sector
Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy. Non-basic sectors, such as retail outlets, are supported by basic sectors.

Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

Clearcut harvesting
A harvesting method in which all trees are removed from an area of land in a single harvest. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding. Note that retention of some live trees and snags for purposes of biodiversity now occurs on most clearcuts.

Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'

Cultural heritage resource
An object, a site or the location of a traditional societal practice that is of historical, cultural or archaeological significance to the province, a community or an aboriginal people.

Culturally modified tree
A tree or a remnant of a tree with evidence of traditional aboriginal forest use.

9 Glossary

Cutblock adjacency

The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.

Deciduous

Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

Drainage

The surface and sub-surface water derived within a clearly defined catchment area, usually bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed. The term is sometimes used to describe an operating area or location.

Employment coefficient

The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Employment multiplier

An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Environmentally sensitive areas

Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.

Forest cover objectives

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).

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Forest cover requirements

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).

Forest inventory

An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Forest Practices Code

Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Forest type

The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.

Free-growing

An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Green-up

The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

Growing stock

The volume estimate for all standing timber at a particular time.

Harvest forecast

The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

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Indirect and induced jobs

Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

Inoperable areas

Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

Integrated resource management (IRM)

The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

Land and Resource Management Plan (LRMP)

A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.

Landscape-level biodiversity

The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.

Landscape unit

A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Long-term harvest level

A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

Management assumptions

Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

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Mean annual increment (MAI)

Stand volume divided by stand age. The age at which MAI assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

Model

An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Natural disturbance type (NDT)

An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.

Not satisfactorily restocked (NSR) areas

An area not covered by a sufficient number of well-spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

Old seral

Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.

Operability

Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

Partial retention VQO

Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).

Partition

A portion of the AAC that is attributable to certain types of timber and/or terrain.

Person-year(s)

One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Pruning

The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

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Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see **Visual quality objective**).
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Scenic area	Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Sensitivity analysis	A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Table Interpolation Program for Stand Yields	A B.C. Forest Service computer program used to generate yield projections for managed stands using a model that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.
Timber harvesting land base	Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.

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Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Variable Density Yield Prediction model	An empirical yield prediction system supported by the B.C. Forest Service, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed composition.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Woodlot licence	An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

In June of 1998 a data package for the Bulkley Timber Supply Area timber supply review was released for public review. As a result of public input, a number of data and management assumptions have been revised. This appendix presents the revised data package used to produce the timber supply analysis.

The following tables and commentary outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Bulkley TSA timber supply analysis. This information represents current forest management in the area. Current management is defined as the set of land-use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced are not included in this appendix. The purpose of the timber supply review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province. Any changes in forest management objectives and practices, and any improvements to the data will be included in subsequent timber supply analyses.

A.1 Inventory Information

Table A-1. Inventory information

Data	Vintage	Update	Source scale
Standard			
Biogeoclimatic ecosystem classification (BEC) zones	1993	—	1:250 000
Forest cover	1997	1998	1:20 000
Planning cell C7	1989	—	1:50 000
Terrain resource information mapping (TRIM)	1995	—	1:20 000
Non-standard			
Resource management zones (from Bulkley LRMP)	1995	—	1:50 000
Draft landscape units	1993	1997	1:50 000
Harvest method mapping (HMM)	1998		1:20 000
Grazing leases, agriculture leases, Telkwa Bulbous Toe	1998	—	1:20 000
Terrain stability mapping	1996	—	1:20 000
Recreation inventory	1983	1988	1:50 000
Visually sensitive areas	1992	1997	1:50 000
Woodlots	1995	1998	1:20 000
Community watersheds	1993	—	1:250 000
High and moderate value grizzly habitat	1993	1998	1:50 000

Data source and comments:

Biogeoclimatic ecosystem classification (BEC)

BEC information was supplied by the Ministry of Environment, Lands and Parks (MELP).

Forest cover

The forest inventory planning (FIP) file is current to 1997 except for harvest depletions, which are current to 1994. Volumes have been projected to 1998.

Planning cell C7

Planning cell C7, which is in the north end of the Bulkley TSA, was provided as a digital overlay. All timber within cell C7 is classified as marginal quality due to the remoteness of the area.

Draft landscape units

Draft landscape units replace former planning units, which were used for the Bulkley LRMP.

Harvest method mapping (HMM)

See Sections A.3.6, "Inoperable areas" and A.3.9, "Helicopter and cable areas."

A.1 Inventory Information

Grazing leases, agriculture leases, Telkwa Bulbous Toe

Grazing lease areas are included in the timber harvesting land base. Agriculture lease areas and the Telkwa Bulbous Toe were excluded from the timber harvesting land base.

Terrain stability mapping (TSM)

TSM is available for parts of the draft Copper Landscape Unit.

Recreation inventory

Management Class 0 recreation inventory polygons were used instead of E1r (environmentally sensitive area — recreation) polygons.

Visual landscape inventory

Visual quality objectives (VQOs) have been established for visually sensitive areas around Babine Lake, and were included in the base case.

Woodlots

Existing woodlot information was provided as a separate layer and was considered more reliable than the information in the forest cover layer.

Grizzly habitat

Mapped high and moderate value grizzly bear habitat in the draft Babine landscape unit were included as a digital layer, and merged into the analysis data set.

A.2 Zone and Analysis Unit Definitions

A.2.1 Management zones (groups)

Management zones represent areas with distinct management emphasis. For example, a zone may be based on a harvesting system, silviculture system, visual quality objective or wildlife consideration. Some areas may be subject to more than one management objective. Grouping enables the analyst to apply overlapping constraints to such areas.

Table A-2. provides general descriptions of the management objectives and related information to be tracked in the analysis. The non-contributing forest (i.e., forested land not available for timber harvesting) is included for consideration in attaining forest cover objectives for landscape-level biodiversity, community watersheds, grizzly and caribou habitat, visual quality objectives and the Babine special management zone. Further information on the forest cover requirements to be applied to these areas can be found in Section A.4.9, "Forest cover requirements."

A.2 Zone and Analysis Unit Definitions

Table A-2. Objectives to be tracked

Zone/group	Management issue
Babine SMZ	This is a resource management zone from the LRMP intended to maintain the fish values of the Babine river.
Agriculture/wildlife	After the forest in this zone is harvested, the land is withdrawn from the timber harvesting land base.
High value grizzly bear habitat	Mature forest cover must be maintained above specified levels in areas managed for high value grizzly bear habitat.
Caribou habitat	Mature forest cover must be maintained above specified levels in areas managed for caribou habitat.
Core ecosystems	A limit is placed on the amount of forest that is allowed to be less than 50 years old.
Landscape corridors	Mature forest cover must be maintained above specified levels in areas required for landscape corridors.
Moderate value grizzly habitat in draft Babine Landscape Unit	A limit is placed on the amount of forest that is allowed to be less than 3 metres tall.
Landscape units	There are 13 draft landscape units modelled in this analysis. This group is used to model draft biodiversity emphasis options and to apply other forest cover constraints.
Community watersheds	Community watersheds are subject to maximum disturbance limits that are applied to the Crown forest area within each watershed.
Visual quality objectives	Limits are placed on the amount of forest that can be disturbed in an area managed for visual quality.
Marginal sawlog and pulpwood	This group was created to track the harvest contribution from these stand types.
Integrated resource management	This zone covers areas in the timber harvesting land base not in any other zone. A 3-metre green-up requirement is applied to limit the rate of harvest in each landscape unit.

Data source and comments:

See Section A.1, "Inventory information," for the sources of the management zone information mentioned above.

A.2 Zone and Analysis Unit Definitions

A.2.2 Analysis unit characteristics

An analysis unit represents forest stands with similar tree species (as indicated by the inventory type group), similar timber growing capability (as indicated by the site index in the forest inventory file) and similar management regimes. Each analysis unit was assigned its own timber volume projection (growth curve).

Yield tables for existing natural stands were derived using the variable density yield prediction (VDYP) yield model. Yield tables for recent plantations and future stands were derived using the table interpolation program for stand yields (TIPSY).

A.2 Zone and Analysis Unit Definitions

Table A-3. Definition of analysis units

Analysis unit	Inventory type groups	Site index range (m @ 50 years breast height age)	Analysis unit number	Age (years)	Area (hectares)
Agriculture/wildlife	All	All	0	All	4 841
Spruce-good-thrifty	21, 23-26	> = 16	111	41-140	6 131
Spruce-good-old	21, 23-26	> = 16	112	> 140	10 264
Spruce-good-managed	21, 23-26	> = 16	113	< 41	3 864
Spruce-medium/poor-thrifty	21, 23-26	< 16	121	41-140	9 719
Spruce-medium-old	21, 23-26	> 10 < 16	122	> 140	23 939
Spruce-medium-managed	21, 23-26	> 10 < 16	123	< 41	13 275
Spruce-poor-old	21, 23-26	< = 10	132	> 140	8 299
Spruce-poor-managed	21, 23-26	< =10	133	< 41	2 431
Pine-all-old	28, 30, 31	All	202	> 140	23 022
Pine-good-thrifty	28, 30, 31	> = 19	211	41-140	9 370
Pine-good-managed	28, 30, 31	> = 19	213	< 41	7 116
Pine-medium-thrifty	28, 30, 31	> = 15 < 19	221	41-140	14 037
Pine-medium-managed	28, 30, 31	> = 1 5 < 19	223	< 41	18 879
Pine-poor-thrifty	28, 30, 31	< 15	231	41-140	5 950
Pine-poor-managed	28, 30, 31	< 15	233	< 41	4 505
Balsam-good-thrifty	18-20	> = 11.5	311	41-140	15 237
Balsam-good-old	18-20	> = 11.5	312	> 140	22 444
Balsam-good-managed	18-20	> = 11.5	313	< 41	1 867
Balsam-medium/poor-thrifty	18-20	< 11.5	321	41-140	3 929
Balsam-medium-old	18-20	> = 8.5 < 11.5	322	> 140	90 340
Balsam-medium-managed	18-20	> = 8.5 < 11.5	323	< 41	396
Balsam-poor-old	18-20	< 8.5	332	> 140	25 618
Hemlock-good-old	12, 13, 15-17	> = 12	412	> 140	3 505
Hemlock-good-managed	12, 13, 15-17	> = 12	413	< 41	278
Hemlock-all-thrifty	12, 13, 15-17	All	421	41-140	644
Hemlock-medium-old	12, 13, 15-17	> = 9 < 12	422	> 140	6 778
Hemlock-poor-old	12, 13, 15-17	< 9	432	> 140	1 774
Spruce/pine (planning cell C7)-medium-all	21, 23-26, 28, 30, 31	All	601	41-140	414
Spruce/pine (planning cell C7)-poor-all	21, 23-26, 28, 30, 31	All	602	> 140	1 006

Due to remote access (north end of Bulkley TSA), timber in planning cell C7 was classified as marginal sawlog.

A.3 Definition of the Timber Harvesting Land Base

A.3.1 Land not owned and administered by the province of British Columbia, private forest land, leases

The total land base is stratified into various ownership codes. Land must be British Columbia Crown land under provincial administration for it to contribute to the land base used to determine timber supply. However, even some areas under provincial administration, such as woodlot licences, do not contribute to timber supply in this analysis. The following ownership types within the district were not considered to contribute to the timber harvesting land base or other forest management objectives in the TSA, and were excluded from the land base modelled in the analysis:

Table A-4. Ownership categories that do not contribute to the timber harvesting land base or other forest management objectives in the Bulkley TSA

Ownership code	Definition
40N	Private Crown grant
50N	Federal reserve
52N	Indian reserve
99N	Small leases

A.3.2 Woodlot licences, agricultural leases, Bulbous Toe

Woodlot licences are managed for timber production but are administered separately from the TSA. While the Minister of Forests initially apportions a part of the TSA AAC to woodlots, once an AAC is allocated to a specific woodlot licence, the area and the associated AAC are no longer administered as part of the TSA. Consequently, allocated woodlots do not contribute to the TSA timber harvesting land base.

Ordinarily, ownership code '77N' is used to identify these areas. However, the Bulkley/Cassiar Forest District provided new woodlot mapping for use in the timber supply analysis (see Table A-1., "Inventory information"), and this information was used instead of the outdated forest cover ownership mapping. Using the new woodlot mapping, 7985 hectares of woodlot licences have been identified as woodlot licences in the TSA. These areas are excluded from the timber harvesting land base.

The AAC attributable to these areas is not included in the assessment of the current AAC for the Bulkley TSA. At the time the Bulkley timber supply analysis was undertaken, the total volume allocated to woodlot licences was 20 000 cubic metres per year. A total of 7000 cubic metres per year in allocated woodlot volume was accounted for in TSR 1 for the Bulkley TSA, and the 'current AAC' harvest level reflected this volume. Accordingly, the difference in volume (13 000 cubic metres per year) has been attributed to additional woodlot licences in this analysis. This woodlot licence volume has been deducted from the total AAC of the Bulkley TSA, resulting in the current AAC volume used in the analysis.

The ownership codes representing agricultural leases were not considered reliable as well. District staff provided information on agricultural leases as a separate map layer. The Telkwa Bulbous Toe is an area of sensitive soils which is not adequately mapped in the ESA data. This entire area was identified in the data provided for agricultural leases. The area removed for agricultural leases and Bulbous Toe was 587 hectares.

A.3 Definition of the Timber Harvesting Land Base

A.3.3 Land classified as non-forest or non-productive forest

Alpine, lakes, rock, etc., represented by inventory type identities 6 and 8, were excluded from the timber harvesting land base.

A.3.4 Non-commercial cover

Inventory type identity 5 represents areas currently occupied by non-commercial brush species. These areas are considered unlikely sites for timber production and were excluded from the area available for timber harvesting.

A.3.5 Land not administered by the British Columbia Forest Service for timber supply

Land under provincial Crown administration may contribute to forest management objectives even if it is not available for timber harvesting. For example, provincial park land provides old-growth to help achieve biodiversity objectives. Areas with the following ownership codes do not contribute to timber supply in the analysis, but are considered in the assessment of forest cover requirements. Forested areas in these ownership classes amounted to 10 164 hectares.

Table A-5. Ownership categories that are excluded from the timber harvesting land base but contribute to some forest management objectives

Ownership code	Definition
60N	Crown / ecological reserves
61C, 61N	UREP (use, recreation, enjoyment of the public)
99C	Miscellaneous leases
63N	Class A parks
67N	Provincial parks, park equivalents, or reserves

Of the provincial Crown ownership codes occurring within the Bulkley TSA, only the following are considered to contribute to timber supply for harvest forecast and AAC determination purposes:

Table A-6. Ownership categories that are included in the timber harvesting land base.

Ownership code	Definition
62C	Crown forest management unit
69C	Large Crown reserves
69N	Small Crown reserves (less than 100 hectares)
77N	Woodlot licences[a]

(a) Woodlots are removed from the timber harvesting land base on the basis of 'licensee' description. See Section A.3.2, "Woodlot licences, agricultural leases, Bulbous Toe."

A.3 Definition of the Timber Harvesting Land Base

A.3.6 Inoperable areas

Operability codes are generally used to describe the presence or absence of physical barriers or limitations to harvesting, logging methods (e.g. cable), and the merchantability of stands. Since physical and economic conditions are highly variable across British Columbia, the method used to interpret and map operability is highly variable and district dependent.

'Harvest Method Mapping' (HMM), which was based on physical accessibility and economic feasibility for harvest, was used to determine limits of operability within the Bulkley TSA. Operability polygons have been assigned a 'primary harvest method' code and a secondary 'stand quality' code (Tables A-7. and A-8).

Table A-7. Operability codes

Primary 'harvest method' codes	Secondary 'stand quality' codes
G — ground	S — sawlog stands
C — cable[a]	M — marginal sawlog stands
H — helicopter	P — pulplog stands
I — inaccessible, forested	D — deciduous-leading stands
	L — sites of low volume and low productivity
	T — sites with density problems (e.g., thick regeneration)

(a) Some H could also be classed as C depending on factors such as block location with respect to access, however only one code is assigned to each polygon.

A.3 Definition of the Timber Harvesting Land Base

Table A-8. Parameters for operability codes

Harvest method mapping codes	Parameters
Primary	
G	≤ 35% slope
C	> 35 < 60% slope
H	60%-90% slope
I	> 90% slope
Secondary	
M — marginal sawlog	Balsam-leading, and, average total tree height < 24 metres and, > 60% subalpine fir by net volume and, net merchantable volume > 150 m^3/hectare at minimum harvestable age.
P — pulplog	Hemlock-leading, and, > 50% hemlock and < 20% spruce by net volume and, net merchantable volume > 175 m^3/hectare, at minimum harvestable age; or: balsam-leading, and, > 50% amabilis and < 20% spruce by net volume, and, net merchantable volume > 175 m^3/hectare at minimum harvestable age; or: > 50% amabilis and hemlock (combined) with < 20% spruce by net volumes and, net merchantable volume > 175 m^3/hectare at minimum harvestable age.
D — deciduous-leading	All deciduous-leading stands.
L — sites of low volume and low productivity	Coniferous stands on low-productivity sites, site index < 10 for spruce-leading, < 11 for balsam and hemlock-leading, < 12 for pine-leading, with stand volumes ≤ 150 m^3/hectare at minimum harvestable age.
T — sites with density problems (e.g., thick regeneration)	Coniferous stands with site index ≥ 15 and with density problems (density > 10,000 stems/hectare, or crown closure > 80%) that achieved the volume parameters (net merchantable volume > 175 m^3/hectare for pulplog-quality, volume > 150 m^3/hectare for marginal sawlog and sawlog-quality stands) but did not achieve the mean stand diameter criteria (25 cm dbh) by the minimum harvestable age.
S — sawlog	All remaining productive forest, including all immature logged blocks, and all other catastrophic loss blocks where silviculture activities have been conducted

A.3 Definition of the Timber Harvesting Land Base

Areas with the following HMM codes were considered inoperable and were removed from the timber harvesting land base.

Table A-9. Inoperable areas.

Harvest method mapping (HMM) code	Reduction per cent (%)
IS, IM, IP, ID, IL, IT	100

A.3.7 Terrain stability in Copper LU

In addition to the HMM exercise, more detailed terrain stability mapping was available for the Copper landscape unit. All areas classified as stability class "E" were removed from the timber harvesting land base.

A.3.8 Riparian management areas

Table A-10. Riparian management areas

Location	Stream class	Riparian reserve zone (RRZ) width (metres)	Riparian management zone (RMZ) width (metres)	Reduction per cent (%) for RMZ area)[a]
Streams				
Within community watersheds (all slopes)	S1	50	20	10
	S2	30	20	10
	S3	13.4[b]	26.7[b]	10
	S4	0	30	5
Outside community watersheds (slopes < 20%)	S1	50	20	10
	S2	30	20	10
	S3, S4	13.4[b]	26.7[b]	10
	S6	0	20	5
Outside community watersheds (slopes ≥ 20%)	S5	0	30	5
	S6	0	20	5
Wetlands	W1	10	40	10
	W3, W4	0	30	5
Lakes	L1	10	20	10
	L3, L4	0	30	5

(a) "Reduction per cent" refers to the percentage of the forested land base that will not be harvested within riparian management zones.

(b) Zone widths shown are weighted averages, calculated using stream class densities (identified in a *Bulkley Stream Inventory Point Sample* summary) and RRZ and RMZ widths from the *Forest Practices Riparian Management Area Guidebook*.

Data source and comments:

Harvest method mapping produced a digital overlay in which streams were classed, then buffered with riparian reserve zones and riparian management zones. When this buffer overlay was merged with forest cover, the resultant polygons were tagged as 'in' or 'out' of riparian reserves or riparian management zones.

The reduction per cent shown in Table A-10. were applied to riparian management zones. Riparian reserve zones were reduced by 100%.

A.3 Definition of the Timber Harvesting Land Base

A.3.9 Helicopter and cable areas

Tables A-11. and A-12. show the HMM codes used to remove areas suitable for helicopter and cable logging from the timber harvesting land base.

Table A-11. Helicopter site criteria

Harvest method mapping (HMM) code	Reduction per cent (%)
HS, HM, HP, HD, HL, HT	100

Table A-12. Cable site criteria

Harvest method mapping (HMM) code	Reduction per cent (%)
CD,CM, CP, CL, CT	100

A.3.10 Sites with low timber growing potential

Stands that do not currently have sufficient timber volumes to make harvesting feasible and are not likely to achieve a harvestable volume over time (based on estimated site productivity) are excluded from the timber harvesting land base (see Table A-8.). All stands with a harvesting history are included in the timber harvesting land base.

Table A-13. Low site criteria

Harvest method mapping (HMM) code	Reduction per cent (%)
GL	100

Note: HL, IL, and CL would be reduced from the land base through helicopter reductions, inoperable reductions and cable reductions respectively.

A.3.11 Problem forest types

Problem forest types are stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability. These types are excluded from the timber harvesting land base.

In addition, cedar, whitebark pine, and deciduous-leading stands were excluded from the timber harvesting land base.

Table A-14. Problem forest types criteria

Species/harvest method mapping (HMM) code	Inventory type groups	Reduction per cent (%)
GD, GT	—	100
Cedar, whitebark pine and deciduous	11, 14, 34-36, 40-42	100

A.3 Definition of the Timber Harvesting Land Base

A.3.12 Current roads, trails and landings (RTL)

Two types of existing RTL exist in the Bulkley TSA: in-cutblock RTL and between cutblock roads. A survey of in-cutblock RTLs was conducted on 25 randomly selected cutblocks. The total kilometres of existing road and trail were reported for a sample of 12 randomly selected mapsheets. This information was then used to determine the total hectares of roads and trails existing on each mapsheet using an average right-of-way width of 20 metres for a total estimated road area of 8340 hectares. Mapsheets within ALR or development outside the Bulkley TSA were not included to ensure data was not affected by non-road or non-district development practices. The current road reduction was applied to stands younger than 100 years.

Future roads, trails and landings reductions were based on a survey of operational plans (three major licensees) for 53 blocks harvested over two years. This survey compared the total area lost to productivity and the total area under permit. The Bulkley/Cassiar Forest District staff estimated the losses to be 6.1% of the available timber harvest land base. All existing stands currently greater than 100 years old were subject to a 6.1% land base reduction after the first harvest.

Table A-15. Estimates for existing and future roads, trails and landings

Location	Age class	Reduction area (hectares) or per cent (%)
Existing in cutblock RTLs	0 to 4	5 890 hectares
Existing between cutblock roads	0 to 4	2 450 hectares
Future RTLs	5 to 9	6.1%

A.3.13 Recreation areas

Management class 0 (very high recreation value) polygons from the recreation inventory were removed from the timber harvesting land base.

A.3.14 Environmentally sensitive areas

Some forest lands are environmentally sensitive and/or significantly valuable for other resources. These areas are identified and delineated during a forest inventory and are called environmentally sensitive areas (ESAs). Table A-16. lists the types of ESAs where the area is either partially or wholly removed from the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

Table A-16. Per cent of environmentally sensitive areas considered unavailable for harvesting

ESA category	ESA description	Outside community watersheds		Inside community watersheds	
		Reduction per cent ESA1	Reduction per cent ESA2	Reduction per cent ESA1	Reduction per cent ESA2
PW	Regeneration/wildlife	50	0	50	0
P	Regeneration	50	50	50	50
PR	Regeneration/recreation	50	0	50	0
S	Soil	20	0	100	0
SPR	Soil/regeneration/recreation	20	0	100	0
SP	Soil/regeneration	20	0	100	0
SPW	Soil/regeneration/wildlife	20	0	100	0
SR	Soil/recreation	20	0	100	0
SW	Soil/wildlife	20	0	100	0
SRW	Soil/recreation/wildlife	20	0	100	0

A.3.15 Newly created parks

The Bulkley LRMP identified several areas which were proposed as protected areas (PA). Table A-17. lists these areas which were subsequently declared as parks. These parks have all been removed from the timber harvesting land base.

Table A-17. Newly created parks

Identifying inventory variables (location descriptors)
Babine Mountains P.A
Babine River Corridor P.A.
Call Lake P.A.
Boulder Creek P.A.
Nilkitkwa P.A.
Neltazul Meadows P.A.
Rainbow Alley P.A.
Burnt Cabin Bog ecological reserve

A.3 Definition of the Timber Harvesting Land Base

A.3.16 Special management zone 1

The Bulkley LRMP also identified several areas earmarked for special management. The status of these areas is recognized through ministerial policy. These special management areas (18 342 hectares total area) have all been removed from the timber harvesting land base.

A.4 Forest Management Assumptions

A.4.1 Utilization levels

Timber utilization levels define the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) by species and are used in the analysis to calculate merchantable volume. Table A-18. shows the standards and licence requirements currently in place for wood utilization in the Bulkley TSA.

Table A-18. Utilization levels

	Utilization		
Analysis unit	**Minimum dbh (cm)**	**Maximum stump height (cm)**	**Minimum top dib (cm)**
Sawlog quality stands	15	30	10
Marginal sawlog and pulplog quality stands	12.5	30	10
Regenerated stands	15	30	10

A.4.2 Volume exclusions for mixed species stands

All deciduous species were excluded from the estimation of volume in coniferous-leading mixed species stands. All stands dominated by deciduous species were excluded from the timber harvesting land base (see Section A.3.11, "Problem forest types").

A.4.3 Minimum harvestable age derivation

Minimum harvestable ages provide an estimate of the minimum age a stand must reach before it can be harvested. They define the lower limit for harvesting. Harvesting may occur in stands at the minimum requirements (for example, to maintain harvest levels for a short period of time or avoid large disruptions in harvest levels). However, most stands will not be harvested until well past the minimum timber production ages because management objectives for other resource values take precedence (e.g., requirements for the retention of older forest).

For this analysis, minimum harvestable ages were defined by the age when the average stem diameter at breast height was 25 centimetres. In addition to the diameter criterion, all spruce- and pine-leading stands, and balsam-leading stands on good sites had to attain a volume of 150 cubic metres per hectare. Balsam-leading stands on medium and poor sites and all hemlock-leading stands had to attain a volume of 175 cubic metres per hectare. If a stand did not meet these criteria by 160 years of age the minimum harvestable age was 'capped' at 160 years old. For managed stands, the average diameter of the largest 250 stems was used, whereas the average diameter of all stems was used for unmanaged stands. Table A-19. shows the minimum harvestable ages as well as the culmination ages for the analysis units used in this TSA.

A.4 Forest Management Assumptions

Table A-19. Minimum harvestable ages

Analysis unit description	Analysis unit number	Culmination age (years)	Minimum harvestable age (years)
Agriculture/wildlife	All	110	110
Spruce—good-thrifty	111	110	100
Spruce-good-old	112	100	100
Spruce-good-managed	113	80	60
Spruce-medium/poor-thrifty	121	130	130
Spruce-medium-old	122	140	140
Spruce-medium-managed	123	110	80
Spruce-poor-old	132	190	160
Spruce-poor-managed	133	180	140
Pine-all-old	202	90	100
Pine-good-thrifty	211	90	90
Pine-good-managed	213	70	50
Pine-medium-thrifty	221	110	130
Pine-medium-managed	223	90	70
Pine-poor-thrifty	231	130	160
Pine-poor-managed	233	140	110
Balsam-good-thrifty	311	110	140
Balsam-good-old	312	110	160
Balsam-good-managed	313	120	80
Balsam-medium/poor-thrifty	321	140	160
Balsam-medium-old	322	140	160
Balsam-medium-managed	323	170	130
Balsam-poor-old	332	180	160
Balsam-poor-managed	333	220	160
Hemlock-good-old	412	110	140
Hemlock-good-managed	413	130	90
Hemlock-all-thrifty	421	110	150
Hemlock-medium-old	422	140	160
Hemlock-medium-managed	423	150	110
Hemlock-poor-old	432	180	160
Hemlock-poor-Managed	433	200	150
Spruce/pine (planning cell C7)-medium-all	601	130	160
Spruce/pine (planning cell C7)-poor-all	602	170	160
Spruce/pine (planning cell C7)-medium-managed	603	110	70
Spruce/pine (planning cell C7)-poor-managed	604	180	130

A.4 Forest Management Assumptions

A.4.4 Harvest scheduling priorities

For the Bulkley TSA base case, the Forest Service Simulator (FSSIM) timber supply model selected stands to harvest based on "relative oldest first" (highest priority given to stands that are furthest above their respective minimum harvestable age).

In addition to prioritizing generally older stands, there is also a high priority to harvest marginal sawlog and pulpwood stands in the analysis. This priority has been established to ensure that the full amount of the partition is harvested at the start of the planning horizon when the age of these stands makes them less likely candidates for harvesting under the relative oldest first harvest priority.

A.4.5 Unsalvaged losses

Table A-20. provides an estimate of average annual volume of timber on the timber harvesting land base that is damaged or killed and **not** salvaged. The unsalvaged losses are deducted from all harvest forecasts shown in the timber supply analysis.

Table A-20. Unsalvaged losses

Cause of loss	Annual unsalvaged loss (m^3/year)
Windthrow	7 391
Mountain pine beetle	2 978
Wildfire	2 557
Tomentosus root rot	20 553
Balsam bark beetle	35 556
Total losses	69 035

Data source and comments:

There is a recent outbreak of spruce budworm encompassing approximately 4000 hectares of mature forest in the Harold Price landscape unit. The effects of this pest are unknown at this time and any losses as a result of spruce budworm will be included in subsequent analyses.

A.4.6 Basic silviculture and regeneration assumptions

The silviculture program guides the mix of treatments to be carried out in the Bulkley TSA. It is assumed that basic silviculture is undertaken on all sites, plus incremental silviculture on some sites. Table A-21. shows the proportion of each analysis unit to be treated under each silviculture regime and the expected average regeneration delay.

Existing stands older than 40 years were assigned to VDYP curves initially, then assigned to TIPSY managed stand yield curves following their first harvest in the simulation. For example, a stand currently in AU 111 would regenerate to AU 113 following harvest, as indicated in Table A-21. Growth in recent plantations (those less than or equal to 40 years as of 1998) and future stands was projected using managed stand yield tables (MSYTs) produced using the B.C. Forest Service table interpolation program for stand yields (TIPSY) growth and yield model. In some cases, natural regeneration is assumed, including cases where advanced regeneration remains after logging. Where advanced regeneration is assumed a "negative age" is used to reflect the assumed average tree age.

A.4 Forest Management Assumptions

Table A-21. Regeneration assumptions by analysis unit

Source analysis units	Regen analysis units	Site index	Regen delay	Method	Method %	Species	Species %	Initial (countable stems/ha)
111, 112, 113	113	18.20	2	Plant	100	Sx	60	2200
						Pl	40	2200
121, 122, 123	123	14.00	2	Plant	100	Sx	60	2500
						Pl	40	2500
132, 133	133	8.45	2	Plant	100	Sx	60	2500
						Pl	40	2500
211, 213	213	20.55	2	Plant	100	Pl	70	2500
						Sx	30	2500
202, 221, 223	223	17.00	2	Plant	100	Pl	70	2500
						Sx	30	2500
231, 233	233	12.21	2	Plant	100	Pl	70	2500
						Sx	30	2500
311, 312, 313	313	14.00	2	Plant	95	Sx	50	2200
						Pl	30	2200
						Bl	20	2200
			– 10	Natural	5	Bl	90	2500
						Sx	10	2500
321, 322, 323	323	9.80	2	Plant	95	Sx	50	4000
						Pl	30	4000
						Bl	20	4000
			– 10	Natural	5	Bl	90	4500
						Sx	10	4500
332	333	7.72	2	Plant	100	Sx	50	4000
						Pl	30	4000
						Bl	20	4000
412, 413	413	13.50	2	Plant	80	Sx	62.5	3500
						Pl	37.5	3500
				Natural	20	Hw	100	3500
421, 422	423	11.00	2	Plant	80	Sx	62.5	3500
						Pl	37.5	3500
				Natural	20	Hw	100	3500
432	433	8.04	2	Plant	80	Sx	62.5	3500
						Pl	37.5	3500
				Natural	20	Hw	100	3500
601	603	15.04	2	Plant	100	Sx	50	2000
						Pl	30	2000
						Bl	20	2000
602	604	9.03	2	Plant	100	Sx	50	2000
						Pl	30	2000
						Bl	20	2000

A.4 Forest Management Assumptions

Data source and comments:

Regeneration delay reflects current operational practice and is defined as the time after harvest but before planting.

Provincial average operational adjustment factors (OAFs) were applied to the managed stand yield curves as recommended by the Ministry of Forests, Research Branch — since no local factors were available. OAF1 (15%) reflects small stocking gaps in stands, while OAF2 (5%) reflects the estimate for decay, waste and breakage that increases with age, passing through 5% at 100 years of age.

A.4.7 Immature plantation history

All stands currently less than 40 years old (as of 1998) have received density control treatments and are considered managed stands.

A.4.8 Not satisfactorily restocked (NSR) areas

The Bulkley TSA forest inventory file was considered up to date for NSR at this time. Total NSR on the timber harvesting land base was estimated at 8994 hectares. Backlog NSR (i.e., harvested prior to 1987) was estimated at 1155 hectares. This backlog NSR will be reforested within 5 years. All current NSR will be restocked within two years.

NSR is restocked in proportion to the current area of each analysis unit in stands less than 20 years old on the assumption that the overall distribution of harvest within analysis units has not changed significantly over this period of time.

A.4.9 Forest cover requirements

As noted in Section A.2.1, "Management zones (groups)," forest cover requirements were applied to model management for a number of objectives. All forest cover requirements were modelled at the landscape unit level. Where forest cover requirements are expressed using a height criterion, the age at which regenerated stands achieve this height was estimated using *SiteTools batch 2.3*. Then the ages were averaged within the landscape unit used. (For example, the age at which all stands within the Chapman landscape unit 3 metres was averaged to arrive at the green-up age of 21 years).

A.4 Forest Management Assumptions

A.4.9.1 Forest cover requirements — landscape-level biodiversity

Only the old-seral guidelines were modelled in the base case, consistent with the assumptions used in the February, 1996 *Forest Practices Code Timber Supply Analysis*. As biodiversity-emphases had not yet been approved for landscape units in the Bulkley TSA when the timber supply analysis was underway, an average old-seral prescription was applied to all landscape units. This average prescription was calculated assuming a distribution of area between biodiversity-emphases of 45% low-biodiversity, 45% intermediate-biodiversity and 10% high-biodiversity. The per cent area of old-seral forest to be maintained over time under each biodiversity-emphasis is based on values from the *Forest Practices Code Landscape Unit Planning Guide* for each of the biogeoclimatic variants in the Bulkley TSA. In addition, old-seral targets for the low emphasis portion of the old-seral constraint have been reduced to one-third the *Planning Guide* value for the first rotation (0 to 70 years), two-thirds of the target for the second rotation (71 to 140 years), and the full target value for the remainder of the planning horizon (141 years onward). The final old-seral requirements calculated using this method for each landscape unit/variant combination are shown in Table A-22.

Table A-22. Old seral requirements by natural disturbance type (NDT)

			Minimum retention area by decade (%)		
Biogeoclimatic unit	**NDT**	**Minimum age (years)**	**< decade 7**	**Decade 7-14**	**> Decade 14**
ESSFwv	1	250	14.2	17.1	19.9
MHmm2	1	250	14.2	17.1	19.9
CWHws2	2	250	6.7	8.1	9.4
ESSFmc	2	250	6.7	8.1	9.4
ESSFmk	2	250	6.7	8.1	9.4
ICHmc1	2	250	6.7	8.1	9.4
ICHmc2	2	250	6.7	8.1	9.4
SBSdk	3	140	8.2	9.9	11.5
SBSmc2	3	140	8.2	9.9	11.5

A.4 Forest Management Assumptions

Sensitivity analyses evaluating the impact of using the current biodiversity emphasis option as well as the new draft biodiversity emphasis option were also performed.

Table A-23. Current and draft biodiversity emphasis options by landscape unit

Landscape unit name	Current biodiversity emphasis option	Draft biodiversity emphasis option
Babine	Intermediate	Low
Blunt	Low	Low
Bulkley	Low	Intermediate
Chapman	Low	Low
Copper	Intermediate	Intermediate
Corya	High	High
Deep Creek	Low	Low
Harold Price	Intermediate	High
Nilkitkwa	High	High
Reiseter	Intermediate	Intermediate
Telkwa	Intermediate	Intermediate
Torkelson	Low	Low
Trout Creek[a]	Intermediate	Intermediate

(a) Kitseguecla was grouped with Trout Creek for analysis purposes.

A.4.9.2 Forest cover requirements — resource emphasis areas

The timber supply model used (FSSIM Version 3.0) can incorporate forest cover requirements that specify both the maximum proportion of an area allowed in a disturbed condition, and the minimum required area of old-age forest. The forest cover requirements applied in this analysis approximate current forest management practices. The following forest cover requirements were applied to each resource emphasis group within each landscape unit.

A.4 Forest Management Assumptions

Table A-24. Forest cover requirements for resource emphasis areas

Resource emphasis	Young forest criteria			Old forest criteria		Land base constraints apply to
	Height criterion (metres)	Age criterion (years)	Maximum allowable disturbance %	Age criterion (years)	Minimum area of older forest retained %	
Babine SMZ				140	30	Forested
IRM and SMZ2	3		33			Timber harvesting land base
Grizzly habitat (outside Babine landscape unit)				80	50	Forested
Caribou habitat				90	50	Forested
Core ecosystems		50	5			Timber harvesting land base
Landscape corridors				80	70	Timber harvesting land base
High value grizzly habitat in Babine LU				80	50	Forested
Moderate value grizzly habitat in Babine LU	3		25			Forested
Community watersheds		5	5			Forested
Retention and Preservation visual quality	5		5			Forested
Partial retention visual quality	5		15			Forested

A.4 Forest Management Assumptions

A.4.10 Operational adjustment site index study (OASIS)

In 1997 the Bulkley TSA was sampled to estimate the proportion of the TSA in each biogeoclimatic zone/subzone/variant/site series combination. Table A-25. shows the results obtained from 500 sample plots randomly distributed throughout the TSA.

Table A-25. Distribution of the Bulkley TSA by BEC zone/subzone/variant/site series

Biogeoclimatic zone/subzone/variant	Site series	Proportion of TSA in site series
CWHws2	01	0.02847
	03	0.01433
	04	0.00724
	05	0.00022
	06	0.01578
	07	0.00669
ESSFmc	01	0.12255
	03	0.00127
	04	0.03858
	05	0.02836
	06	0.04149
	07	0.01636
	08	0.01618
	09	0.00076
	10	0.02080
	31	0.01182
ESSFwv	01	0.05175
	02	0.00044
	03	0.00895
	05	0.01538
	07	0.00451
	31	0.00625
ICHmc1	01	0.02800
	03	0.02044
	04	0.01455
	06	0.00247
MHmm2	01	0.02498
	03	0.00775
	05	0.00364
	06	0.00364
	07	0.00364
SBSdk	01	0.00727
	06	0.00727
SBSmc2	01	0.15451
	05	0.13207
	06	0.05036
	09	0.02927
	10	0.03931
	12	0.00538
	31	0.00727

A.5 Volume Estimates for Existing Stands

The variable density yield projection (VDYP) model, version 6.5a developed and supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural stands. Table A-26. shows the volume estimates by analysis unit for existing natural stands.

The volumes shown in Tables A-26. and A-27. were reduced by a further 2.3% when the timber supply model was run to account for the impact of wildlife trees retained in all cutblocks in the Bulkley TSA.

Table A-26. Timber volume tables for existing natural stands (cubic metres/hectare)

	Analysis units (existing stands)								
Age	**0**	**111**	**112**	**121**	**122**	**132**	**202**	**211**	**221**
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	5	0	1	0	0	0	17	23	4
40	24	9	11	1	1	0	61	78	35
50	56	49	55	10	7	1	105	128	76
60	93	99	106	38	31	2	146	172	114
70	129	144	152	75	65	7	182	211	147
80	161	183	191	110	99	20	214	246	178
90	191	217	225	141	129	39	244	278	206
100	217	247	255	170	157	60	271	307	231
110	241	273	280	196	182	81	296	334	255
120	263	295	301	219	204	101	319	359	278
130	283	316	322	241	226	121	340	382	299
140	298	333	339	259	244	139	354	396	313
150	311	348	353	276	260	156	365	407	325
160	320	359	365	290	274	172	373	415	333
170	327	369	375	302	287	186	378	419	338
180	332	377	384	312	298	200	380	421	340
190	336	383	391	321	307	212	380	419	340
200	341	390	398	329	316	224	383	422	342
210	345	396	404	337	325	235	386	424	345
220	350	401	409	344	332	245	389	427	348
230	354	406	414	351	339	255	392	430	351
240	357	410	419	357	346	264	395	432	354
250	361	414	423	363	351	272	398	435	356
260	363	417	426	367	355	278	400	437	358
270	366	419	428	370	359	283	402	439	360
280	368	422	430	374	362	288	404	441	362
290	370	424	432	377	365	293	406	443	363
300	372	425	434	380	368	297	407	444	364
310	373	427	436	382	370	301	408	446	366
320	374	429	437	384	373	305	410	447	366
330	376	430	438	386	375	309	411	448	367
340	377	431	439	388	376	312	412	449	368
350	378	432	440	390	378	315	412	450	368

(continued)

A.5 Volume Estimates for Existing Stands

Table A-26. Timber volume tables for existing natural stands (cubic metres/hectare)

	Analysis units (existing stands)								
Age	**231**	**311**	**312**	**321**	**322**	**332**	**412**	**421**	**422**
10	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	1	10	7	2	1	0	1	1	0
40	7	30	22	13	11	3	6	6	1
50	31	61	48	27	24	14	45	38	4
60	61	93	77	49	41	25	105	86	32
70	88	124	107	75	65	38	156	134	80
80	114	150	131	94	84	52	201	177	124
90	138	174	153	113	101	65	240	214	163
100	160	196	173	130	117	77	272	246	198
110	181	217	192	146	132	89	300	274	229
120	201	237	210	162	147	99	324	298	256
130	220	256	228	177	161	110	348	321	282
140	233	274	244	192	175	120	369	342	306
150	244	291	260	206	188	130	388	361	328
160	252	306	275	218	200	140	405	377	348
170	258	320	289	231	212	149	420	391	366
180	261	334	302	242	223	158	433	404	382
190	262	346	314	253	234	166	445	415	397
200	266	359	326	264	245	175	456	426	411
210	269	370	338	274	255	183	466	436	424
220	272	382	349	284	265	190	475	445	436
230	275	393	360	294	275	198	484	453	447
240	278	403	370	304	284	206	492	461	457
250	280	414	380	313	293	213	499	469	466
260	282	416	382	314	295	213	505	475	473
270	284	418	384	316	296	214	510	480	480
280	285	420	386	317	297	215	514	486	486
290	286	421	388	319	299	215	519	491	491
300	287	423	389	320	300	216	523	495	497
310	288	425	391	321	301	217	527	500	502
320	289	426	392	323	302	217	530	504	506
330	289	428	393	324	303	218	534	508	511
340	289	429	395	325	304	218	537	512	515
350	289	430	396	326	305	219	540	515	519

(continued)

A.5 Volume Estimates for Existing Stands

Table A-26. Timber volume tables for existing natural stands (cubic metres/hectare) (concluded)

	Analysis units (existing stands)		
Age	**432**	**601**	**602**
10	0	0	0
20	0	0	0
30	0	2	1
40	0	18	3
50	1	48	10
60	3	82	20
70	8	114	32
80	35	144	44
90	69	172	57
100	102	198	71
110	132	222	88
120	160	245	105
130	186	267	123
140	211	282	138
150	233	294	152
160	254	302	164
170	274	308	175
180	292	311	184
190	308	312	192
200	324	315	200
210	338	318	208
220	352	322	216
230	364	325	223
240	376	328	230
250	387	331	236
260	395	333	241
270	402	335	245
280	409	337	250
290	416	339	253
300	422	341	257
310	428	342	260
320	434	343	263
330	439	344	266
340	444	345	268
350	449	346	271

A.6 Volume Estimates for Regenerated Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 2.1 alpha D, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands. Existing managed stands were assumed to be all stands with an age of 40 years or less as of 1998. The area-weighted site index for each analysis unit along with the regeneration assumptions in Table A-21. were used as inputs to TIPSY.

Table A-27. displays the volume tables for managed stands. These volume tables are generated from TIPSY for ages where TIPSY data exists, and estimated for ages beyond the TIPSY data set. Volumes are assumed to remain constant after 350 years of age.

Table A-27. Projected volumes for managed stands using TIPSY

	Analysis units (managed stands)								
Age	**113**	**123**	**133**	**213**	**223**	**233**	**313**	**323**	**333**
10	0	0	0	0	0	0	0	0	0
20	0	0	0	2	0	0	0	0	0
30	12	2	0	40	9	0	1	0	0
40	58	11	0	122	45	4	9	0	0
50	134	40	2	206	106	16	33	2	0
60	207	86	4	276	164	36	78	8	2
70	268	138	12	329	217	67	130	22	4
80	322	188	27	370	260	102	179	43	10
90	363	229	48	400	300	134	221	70	22
100	394	266	74	423	326	164	260	98	40
110	414	302	99	440	347	188	298	130	58
120	431	329	128	454	363	210	330	157	78
130	445	348	153	464	378	230	353	182	100
140	456	362	174	468	388	250	370	206	123
150	464	374	196	474	398	264	384	228	141
160	470	382	214	474	406	276	395	246	158
170	470	391	234	474	412	284	405	265	177
180	469	398	252	474	417	294	412	280	194
190	471	405	265	474	420	300	422	293	210
200	470	408	278	474	422	306	427	304	226
210	472	413	289	474	423	312	432	313	238
220	472	414	296	474	426	316	434	321	250
230	472	417	304	474	426	318	437	326	260
240	470	419	310	474	428	320	438	331	266
250	470	420	313	474	425	322	439	337	274
260	470	419	318	474	424	324	440	343	278
270	470	418	322	474	420	326	438	345	284
280	470	416	324	474	418	326	437	351	286
290	470	414	327	474	414	326	434	353	291
300	470	414	327	474	414	326	433	354	291
310	470	414	327	474	414	326	433	354	291
320	470	414	327	474	414	326	433	354	291
330	470	414	327	474	414	326	433	354	291
340	470	414	327	474	414	326	433	354	291
350	470	414	327	474	414	326	433	354	291

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-27. Projected volumes for managed stands using TIPSY (concluded)

	Analysis units (managed stands)				
Age	**413**	**423**	**433**	**603**	**604**
10	0	0	0	0	0
20	0	0	0	0	0
30	0	0	0	2	0
40	6	2	0	16	0
50	24	6	0	52	2
60	63	19	2	106	6
70	111	44	6	166	14
80	160	78	13	215	34
90	204	114	29	258	58
100	243	155	49	301	86
110	281	186	71	336	114
120	311	217	97	363	142
130	340	244	123	382	166
140	358	271	148	393	187
150	372	294	168	406	209
160	386	312	190	416	230
170	394	328	208	425	248
180	405	340	228	434	266
190	414	350	245	438	278
200	422	359	260	444	292
210	428	366	273	449	300
220	434	374	284	446	310
230	439	381	295	444	318
240	443	384	302	446	326
250	447	388	308	445	330
260	447	393	315	444	335
270	448	396	319	442	339
280	451	398	324	444	342
290	451	399	328	443	345
300	452	400	329	443	345
310	452	400	329	443	345
320	452	400	329	443	345
330	452	400	329	443	345
340	452	400	329	443	345
350	452	400	329	443	345

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The socio-economic analysis portion of this report identifies employment and income impacts, changes in government revenues, and community impacts as a result of changes in the TSA's harvest levels over time. Some of the assumptions used in this report are as follows:

- **Employment multiplier** — employment multipliers are used to estimate indirect and induced employment impacts of a change in direct industry activity. The calculation of employment multipliers is based on analytical assumptions and data collected at a specific time period. The multipliers reflect industry and employment conditions at that time and may not accurately reflect industry and employment conditions in the future.
- **Employment coefficient** — employment coefficients are ratios of person-years of employment per 1000 cubic metres of timber harvested. These ratios are used to estimate employment levels associated with alternative harvest rates. This method of analysis assumes that the industry structure will be the same in the future as it is today. While reasonably accurate in the short term, employment coefficients may change in the future due to changes in market conditions, product mix or production technologies.
- **Timing of impacts** — employment impacts are shown to occur simultaneously with a change in the harvest level. While this assumption is reasonably accurate for the harvesting sub-sector, employment estimates for the silviculture and timber processing sub-sectors may not be as coincidental. As well, indirect and induced impacts tend to occur over a longer period, as levels of business and consumer spending adjust to changes in harvest levels.
- **Operating thresholds of mills** — it is unlikely that impacts on timber processing employment due to changes in harvest levels will be in direct proportion to the harvest changes (i.e., a 10% change in harvest may not lead to a 10% change in timber processing employment). Impacts on timber processing employment are more likely to occur step-wise related to operating thresholds of mills. For example, if a mill's timber supply is reduced, its operating threshold is reached when the decrease in timber supply causes it to lay off a shift of workers or to close the mill, either temporarily or permanently. Conversely, if the timber supply to the mill is increased, a processing threshold is reached when the mill has to decide whether to add another shift of workers or new capacity to process the increase in timber supply. In both cases, the per cent change in employment in the mill would probably differ from the per cent change in the timber processed. Because mills have many different operating configurations, accurately predicting an individual mill's operating threshold is impossible. As a result, impact figures pertaining to employment in timber processing are best interpreted as size of change rather than as precise changes in employment levels.
- **Government expenditures** — provincial government expenditures are more related to government policy and population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite changes to the harvest level and subsequent changes in government revenues from the forestry sector. However, provincial government expenditures would likely change if a community's population significantly changes. This would amplify the community impacts of losses or gains in forestry sector jobs.
- **Proportional harvest reductions** — harvest reductions are assumed to be proportionately distributed among all licensees and all forms of tenure within the TSA.

B.2 Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the TSA. Other general economic data are from BC STATS, the Ministry of Finance and Corporate Relations, Statistics Canada and local communities. Estimates of taxes paid by the forest industry are from PriceWaterhouseCoopers.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1. harvesting;
2. silviculture; and
3. timber processing.

Employment and income impacts were estimated in several steps. The first step was to assess current activity in each of the three sub-sectors. Then, indirect and induced employment and employment income impacts were estimated, using data from Ministry of Finance and Corporate Relations (1996) and Statistics Canada. Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log salvage, planning and administration functions and log transportation. The employment multipliers used in this analysis define activities such as road building or maintenance work as indirect employment rather than direct employment because the forestry sector and other basic sectors purchase these services.

Data on employment, place of residence and timber flows were obtained from responses to questionnaires that were sent to licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of residents *versus* non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1. TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and
2. Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting-related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients per 1000 cubic metres. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part-time during the year. Because of this, information on silviculture employment was converted into equivalent full-time person-years of employment. Respondents were also asked to estimate the percentage of their silviculture employees who resided within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production and sources of timber was gathered from mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was pro-rated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber supply is from the harvest of the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest. Employment figures were also adjusted to reflect the residences of workers (i.e., those who lived within the TSA and those who lived outside the TSA). Employment in timber processing that is supported by chip by-products from milling operations was also similarly estimated.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employment in the forestry sector refers to those who provide goods and services to firms directly engaged in the basic forestry sector (for example, those who build or maintain road for log transport). Induced employment refers to those who provide the goods and services purchased by employees who are directly and indirectly engaged in the industry (for example, those who work in retail outlets). Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance and Corporate Relations.

Two sets of employment multipliers were calculated for this report: a migration multiplier and a no-migration multiplier. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that displaced workers remain in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

The TSA and provincial employment multipliers used in the Bulkley TSA analysis are shown in Table B-1.

B.2 Economic Impact Analysis Methodology

Table B-1 Employment multipliers — Bulkley TSA

Forestry sub-sector	Bulkley TSA migration multiplier	Bulkley TSA no-migration multiplier	Provincial (interior) migration multiplier	Provincial (interior) no-migration multiplier
Harvesting	1.29	1.21	2.14	1.80
Solid wood processing	1.32	1.21	2.29	1.93
Plywood	1.32	1.21	1.93	1.64
Pulp	1.57	1.44	3.02	2.48

Sources: Ministry of Finance and Corporate Relations. 1999. The 1996 Forest District Tables.

Ministry of Finance and Corporate Relations. 1996. A provincial impact estimation procedure for the British Columbia forestry sector.

Estimates of employment income

Employment income was calculated using average income estimates for workers in the forest industry. Based on Statistics Canada data, the weighted average annual pre-tax income (less benefits) for forestry sector workers in 1999 was:

$46,956 for those working in logging and forestry services;

$44,980 for those working in solid wood manufacturing; and

$58,136 for those working in pulp and paper mills.

Those in indirect and induced occupations earned approximately $30,732. Income taxes were calculated based on marginal tax rates of 23–28% with one-third of the total income tax paid accruing to the province.

Employment estimates of alternate timber supply levels

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. Note that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in future years. Therefore, the employment estimates should be viewed as indicators of size of change rather than as precise estimates of changes in employment levels.

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated (Table B-2).

B.2 Economic Impact Analysis Methodology

Table B-2. Estimates of provincial government revenues — Bulkley TSA

	Average annual revenue 1998-2000 ($ millions)	Revenue ($ per '000s m^3)
Stumpage and related payments[a]	14,800	18,000
Forest industry taxes[b]	5,760	7,000
Employee income tax[c]	5,975	7,250
Total	26,525	32,250

(a) Source: Ministry of Forests, Revenue Branch.

(b) Based on estimates by PriceWaterhouseCoopers. Includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

(c) Estimated from Revenue Canada income tax rates and includes only the provincial share of income taxes paid.